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HIGHWAY FOCUS

MARCH 1980 VOLUME 12, NO. 1

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U.S. DEPARTMENT OF TRANSPORTATION / Federal Highway Administration

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FOREWORD

For the past several years, the Federal Highway Administration (FHWA) has vigorously promoted a Minority Business Enterprise (MBE) program to increase the participation of MBE's in highway projects financed, in whole or in part, with Federal funds. In order to stress the importance and concern with which the FHWA views its MBE program, it has been designated as a National Program Emphasis Area each year since 1975. In fiscal year 1979, MBE Federal-aid highway contract awards reached an unprecedented high of $163.7 million. In the 4-year period between 1975 and 1979, MBE awards on Federally assisted work has increased at an annual average rate approximately $34 million. This outstanding achievement would not have been possible without the full support and dedication of the highway construction contractors and associated organizations, State highway agencies, and FHWA at both the field and Washington Headquarters levels.

One of the key elements to the success of FHWA's MBE program is the sharing, by all parties, of innovative techniques which proved successful in increasing MBE participation.

In order to further disseminate successful techniques and approaches which promote increased MBE participation in Federal-aid work, FHWA field offices were requested to solicit appropriate information pertaining to same. The included articles indicate various concepts and approaches undertaken by some States and others regarding this program. This material is presented as an informational exchange on a national basis.

"FOCUS" READER SURVEY

The September 1979 (Vol. 11 - No. 3) issue of "Highway Focus" contained a reader survey questionaire combined with a self-addressed reply sheet for eventual return to FHWA Headquarters in Washington, D.C. A two percent reply of the overall distribution was received regarding the survey questions. The replies are integrated as follows:

Reply Sources

States	28%	Private Industry	25%
Counties	5%	Highway Promotional Organizations	3%
FHWA	20%	Universities	5%
Other U. S. Gov't. Agencies	7%	Foreign Countries	7%

Interest

a. General Issues	90%
b. Special Issues	50%

Technical Data

a. Greater Degree of Technical Info. Desired	7%
b. Less Degree of Technical Info. Desired	3%
c. Retain as is	90%

Format

a. Satisfactory	97%
b. Improvement Needed	3%

Reference Data

a. Material Beneficial	69%
b. Material Occasionally Beneficial	28%
c. Material Not Beneficial	3%

Frequency

a. 3 Issues per year	20%
b. 4 Issues per year	60%
c. More than 4 issues per year	20%

Comments

Sixty (60%) percent commented of which: 97%-complimentary
3%-suggested more maintenance and references

COVER

Photograph shows the President of CDS Construction Company (left), a minority contractor, reviewing plans of the Edens Expressway (Chicago) with a representative of the Chicago Economic Development Corporation (CEDCO). The CEDCO is funded by various governmental agencies in the Chicago area and offers a full range of services to small and minority contractors, free of charge.

This publication is one of a series prepared periodically for distribution to Federal Highway Administration offices, State highway departments, and any other interested parties. Material has been composed from narrative reports covering highway engineering operations.

The opinions expressed in, or conclusions that may be drawn from the material contained in these special reports, are not to be taken as Federal Highway Administration endorsement. Republication for further distribution by field offices is permitted, but to prevent a situation wherein Federal Highway Administration endorsement could be implied, such republications are not to have Federal Highway Administration identification thereon.

ISSUED BY: Experimental Construction and Applications Branch
Construction and Maintenance Division
Office of Highway Operations

Editor: Edward C. Jastremski

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MINORITY BUSINESS ENTERPRISE PARTICIPATION IN FEDERAL-AID HIGHWAY CONSTRUCTION

By: A. L. (Tony) Alonzo, Director
Office of Construction & Maintenance
Region 6 - Federal Highway Administration
U.S. Department of Transportation

Introduction

Since November 3, 1975, the Federal Highway Administration has been implementing a program of increased minority business enterprise participation in highway construction. This program has been a different type of activity as compared to the Title VI requirements of the 1964 Civil Rights Act and those of Equal Employment Opportunity pursuant to Executive Order 11246 and Title 23. In order to provide a better understanding, a brief overview of the differences in these programs has been prepared.

1. The Civil Rights Act is concerned with how programs affect individuals and the provisions implementing these requirements are intended to assure that their rights are protected.

2. EEO is involved with the employment of individuals and the provisions set forth not only to protect their rights in employment but provide affirmative action to increase minority participation in both employment and on-the-job training.

3. MBE, on the other hand, is a different sort of program since it is aimed primarily at affirmative action and the accomplishments resulting therefrom. FHWA's program is one of seeking out minority businesses--it is a program of seeking out ways in which we can increase the participation of minority businesses.

History

The history of the program has been brief, but the accomplishments of the voluntary program have been significant. FHWA's program can be traced partially to the 1964 Civil Rights Act and partially to E.O. 11625. The philosophy of the program from the start has been one of affirmative action and voluntary activity.

Minority business enterprise participation in Federal-aid highway construction had a slow beginning as evidenced by a total of $32.5 million awarded to MBE's in FY 1975. This, however, increased to $123.2 million awarded to MBE's in FY 1978 for an outstanding increase of 279 percent. There is still some room for increase when compared to a Federal-aid program of some $6.7 billion nationwide during a calendar year 1978. The goal established for FY 1979 is $150 million.

MBE Requirements

The requirements that outline FHWA's program for increasing MBE participation on FA highway construction contracts are contained under Federal Highway Program Manual 6-4-1-8.

The FHPM directive describes the functions of three basic governmental agencies involved; namely, the State, OMBE, and FHWA. The directive lists numerical goals for each State in getting MBE's to become prequalified contractors. The FHPM also includes brief guidelines for establishing dollar goal amounts in connection with the award of contracts to MBE's. Items which are of a more specific nature include the following:

1. Seek out, identify, and compile a list of MBE's wishing to participate in highway construction and furnish the list to all prime contractors receiving bid proposals. Also, minority firms are to be provided the opportunity to obtain identity of those contractors taking out proposals where it is not precluded by State law.
2. Include special provisions in proposals requiring certification of the contractor's intent to subcontract and his affirmative action to seek out and consider potential minority subcontractors. Failure to certify would make the bid non-responsive.
3. Required this same affirmative action for contractors deciding to sublet after the contract is awarded.
4. Contractors are required to name a liaison officer to administer the contractor's MBE program.

Certain other actions to increase MBE participation were also recommended for consideration such as training seminars, restrict size of contracts, and maintain adequate records of results and progress. Also, some reporting requirements relative to MBE contract awards were established.

As previously indicated, the FHWA's MBE program has been a program based on a cooperative and voluntary affirmative action approach. Because highway construction is a technically sophisticated, highly competitive and capital-intensive industry, considerable time is needed to develop successful minority participation in the field and the support of those firms already in the industry is necessary.

Problems

What are some of the problems that have confronted the States, the industry, FHWA, and other MBE firms? There are many unique problems that have arisen but the following five items appear to be the more common ones:

1. Lack of or small number of minority firms prequalified or qualified to bid on Federal-aid work.

2. Inability of minority businesses to secure bonding as a prime or subcontractor.

3. Lack of sufficient experience in the estimating and bidding process.

4. Poor cash flow.

5. Apprehension to perform Federally-aided work.

There is a sixth item that deserves mentioning, and that is the inadequate number of minority contractors who are technically trained to handle the more complex type of project. The first five of these items can reasonably be handled in some form, but the sixth item will have to develop over a longer period of time.

Affirmative Actions

What have the States, the industry and FHWA done to help the minority business enterprise program? The following are some of the specific actions taken to date:

1. Some States have relaxed their prequalification requirement for small contracts under $100,000.

2. Due to some deficiencies in the business skills, some States have entered into supportive services contracts for purposes of training minority businesses in the preparation of estimates for bidding purposes. Other contracts have been established to help MBE's better manage their operations and to create a better understanding of the competitive bidding and subcontracting processes.

3. The SBA has established a "bond guarantee" program for purposes of helping MBE's secure contract bonding. Information in connection with this program has been made available to all State highway agencies through our division offices.

4. A number of States have specified MBE goals on Federally-aided contracts.

5. SBA, in conjunction with loan institutions, is providing assistance to minority businesses for purposes of improving their cash flow.

6. Construction contractors have established programs through their local associations for purposes of contacting prospective MBE contractors within their States.

7. State highway agencies have developed lists of prospective minority businesses for distribution to the construction community.

8. Some construction prime contractors have helped MBE subcontractors obtain bonds.

As some of these items indicate, the FHWA's MBE program has been a cooperative effort to date. The program has produced continuous growth in MBE participation over the past three years. FHWA is optimistic that the trend established during the past three years will continue into the future.

New Ways to Increase MBE Participation

Aside from mandatory provisions, there are many acceptable approaches for promoting and implementing procedures for increasing MBE participation in the Federal-aid highway construction program. The States and FHWA have to be very careful in utilizing special MBE procedures since, by law, the competitive bidding process has to be maintained and preserved. Moreover, the States and FHWA have to make sure the civil rights of others are not violated. All of this means that programs have to be innovative and individuals have to be better informed in contract administration concepts. The following are some suggested procedures for increasing MBE participation.

1. Expand the use of subcontracting to MBE's as a means of training and grooming them toward becoming a prequalified bidder or to work as a Federal-aid highway subcontractor. This could be accomplished using a bid item to train MBE's, with reimbursement to be made a regular contract item.

2. Set up special lettings for MBE's to bid on with scope of work limited to their capabilities and bidding capacity. This contract amount would have to be reported as an exception to the competitive bidding process similar to force account work on FA projects.

3. In conjunction with local offices of SBA and OMBE, contracting agencies can establish procedures for the use of the SBA surety bond guarantee program.

4. The State of Maryland and the City of Baltimore have both established contract provisions aimed at increasing MBE participation. These provisions include the following:

    a. Affirmative action certification at the time the bid is submitted.
    b. Minimum actions for the contractor to follow in providing opportunity for MBE participation.
    c. The provisions establish minimum percentage of contract to be sublet to MBE's including material suppliers.
    d. The contract provisions allow for an exception or waiver of the minimum percentage upon written request based on supported evidence that the contractor's affirmative action could not produce sufficient MBE's to achieve that percentage.

5. There is one State nationwide that has established a dollar goal amount to be subcontracted to MBE's. An achievement of the money goal would require no further action; however, a non-achievement of money goal would require evidence of affirmative action to achieve the goal within 7 days of being determined the low bidder.

6. The question of a set-aside program is a matter that has been around since the start of our MBE program. Some States and Federal agencies have pursued this course of action. FHWA has no set-aside program. There are some States currently considering the establishing of laws aimed at setting up statewide set-aside programs. The question has come up regarding FHWA's position to a State set-aside program. States electing to adopt set-aside laws for MBE's may do so without jeopardizing Federal-aid participation in highway construction contracts. FHWA is not requiring that such laws be passed in each State, but neither will the passage of such laws establishing MBE set-aside programs be discouraged. FHWA believes that a competitive set-aside program is a more preferred program wherein only MBE individuals are permitted to submit a bid on competition with MBE's rather than mandatory specifying MBE selection.

Attachment I, II, and III provide an overall profile of FHWA's minority business enterprise program and will provide a thumbnail sketch of all our applicable directives, methods by which MBE's can participate in the program, general MBE contract information and some acceptable approaches for promoting and implementing increased MBE participation.

Future

What's in store for the future? The FHWA is currently proposing to revise FHPM 6-4-1-14, which deals with FA Force Account work. The new directive will contain a new provision which makes the determination that it is in the public interest to accomplish force account work through the use of a competitive MBE program. Consideration of bids or proposals will be limited to those submitted by MBE's with capabilities to accomplish the contract work.

Special procedures are required to perform work on a force account or other basis and it is through these procedures that the competitive MBE program will be implemented.

An item of significant nature that will have a bearing on both Federal and Federally-aided programs and on both construction and non-construction contracts is the proposed rulemaking issued by DOT on May 17, 1979. The Office of the Secretary of Transportation has issued its proposed MBE regulations in the Federal Register for review and comment, and upon final issuance, FHWA is expected to cancel its own regulations. A comparison of FHWA's rulemaking with those being proposed by DOT indicates that procedures would complement and support those of DOT.

Conclusion

FHWA's program of voluntary and cooperative action has been successful. The FHWA MBE program could not have succeeded without the dedication and support of the State highway agencies, highway construction contractors, including MBE's, and their respective organizations.

Contracting is a highly competitive business and successful MBE's take time to develop. It appears five years or so will be a reasonable time to obtain a respectable level of MBE participation. Bonding and financial problems appear to be the major deterrent at present. Some deficiencies in general business skills are also providing additional problems which could be resolved through FHWA's supportive services program. A move is afoot to develop some legislation to allow Federal-aid for bond insurance or guarantees for MBE's. FHWA is optimistic that the upward trend of minority business enterprise participation in highway work will continue. FHWA's record to date supports the President's mandate to achieve increased MBE participation in government programs.

Attachment I

Profile of Region 6 Minority Business Enterprise Activities in Highway Construction

I. General Information
   - A. Current Directives Involving MBE
     1. FHPM 6-4-1-8
     2. FHPM 6-4-1-6
     3. FHPM 6-4-1-2
     4. FHPM 6-4-1-1
   - B. Current Directives Involving Contract and Force Account Work
     1. FHPM 6-4-1-6
     2. FHPM 6-4-1-14
   - C. Methods of Performing Construction Work
     1. Competitive Bidding
     2. State Force Account
     3. Subcontract Work

II. Methods by Which MBE's Can Participate in Federal-Aid Highway Construction Work
   - A. Competitive Bidding Process
   - B. Subcontract
   - C. Through Supply Functions on Federal-Aid Construction Projects

III. General MBE Contract Information
   - A. FHWA's current program is one of affirmative action and is voluntary in nature.
   - B. FHWA has no MBE set-aside program. However, the Office of the Chief Counsel has determined that the set-aside program is a legal approach to increasing MBE participation under Title 23. The legality of using this approach in the individual States will depend on whether it is consistent with each State's laws. This has been adopted as the FHWA policy.
   - C. States electing to adopt set-aside laws for MBE's may do so without jeopardizing Federal-aid participation on highway construction contracts. FHWA is not requiring that such laws be passed in each State, but neither will the passage of laws establishing MBE set-aside programs be discouraged. We do believe that a competitive set-aside program is a more preferred program wherein only MBE individuals are permitted to submit a bid on competiton with MBE's.
   - D. The proposed FHPM 6-4-1-14, Contract and Force Account, contains a new provision which makes the determination that it is in the public interest to accomplish force account work through the use of a competitive MBE set-aside program. Consideration of bids or proposals will be limited to those submitted by MBE's with capabilities to accomplish the contract work.

E. The Office of the Secretary of Transportation will be issuing proposed MBE regulations in the Federal Register for review and comment. FHWA does not plan to revise its current regulations until after the OST rulemaking process results in final regulations. At that time, it is proposed to revoke the existing FHWA regulations for MBE.

IV. Acceptable Approaches for Promotion and Implementation to Increase MBE Participation

A. Expanded use of subcontracting to MBE's as a means of training and grooming them toward becoming a prequalified bidder or to work as a Federal-aid Highway subcontractor. This could be set up as a bid item to train MBE's. (See copy of attached MBE Training Special Provision.)

B. Set up special lettings for MBE's to bid on with scope of work limited to their capabilities and bidding capacity. This set-aside amount would have to be reported as an exception to the competitive bidding process similar to Force Account work.

C. Consistent with State laws or regulations, contracting agencies may want to include materials suppliers and lessors of equipment along with subcontractors as identified MBE's. This is acceptable, although present FHWA regulations do not consider these classifications as credit toward achieving MBE dollar goals. We plan to pursue this matter further with Washington in an effort to allow credit for materials suppliers and lessors of equipment toward goals since in actuality they are as much a part of the Federal-aid highway program as the contractors or subcontractors.

D. In conjunction with local offices of SBA and OMBE, contracting agencies can establish procedures for the use of the SBA Surety Bond Guarantee Program. Reference is made to Region 6 memorandum of April 10 which explains this new program.

E. The State of Maryland and the City of Baltimore have both established contract provisions aimed at increasing MBE participation. A copy of the contract provisions has been attached for your information. These programs provide the following:

1. Require completion of an "Affirmative Action Certification" by the bidder. Failure to complete this certification makes bid non-responsive.
2. Sets up minimum actions for the contractor to perform in providing opportunity for MBE participation.
3. Establishes minimum percentage of contract to be sublet to MBE's. This includes suppliers as well.
4. Allows for an exception or waiver of the minimum percentage upon written request based on supported evidence that the contractor's affirmative action could not produce sufficient MBE's to achieve that percentage.

F. A contract provision has been in use in Washington State on a pilot or trial basis for a period of time with reported satisfactory results. A copy of this provision is also attached for your information. This provision provides for a dollar goal to be subcontracted to MBE's. It also requires completion of a certification in order for contract bid to be considered responsive. Achievement of money goal requires no further action. Non-achievement of money goal requires evidence of affirmative action to achieve the goal within 7 days of being determined to be low bidder.

This special provision was used in Washington only on a selected project basis. MBE's to be considered for subcontracting were prioritized as to location or previous experience with the prime contractor.

G. The contracting agency could establish a set-aside consistent with State laws in conjunction with the subcontracting of Federal-aid highway construction. A special provision could be developed consistent with FHWA Notice N 4720.2 dated January 20, 1976. In conjunction with this proposal, the contracting agency could establish escape clauses similar to the Maryland and Washington provisions based on the contractor's affirmative action and the documentation thereof.

H. Intensive screening of projects to select these items or portions of work that can be set up for specific MBE participation. Also in this area smaller projects could be set up to take advantage of certain MBE capabilities and work area.

I. There is another approach that possibly the contracting agency may want to promote called the "Big Brother Concept." This approach necessarily, owing to its means of application, is accomplished outside the agency's operations and the Federal-aid highway program. It would require negotiation or promotional efforts on the part of the agency with the AGC or other contract or organizations to develop such a program.

This program can be accomplished by either the organization inviting MBE's to their meetings to become acquainted with the contractors that they would be dealing with and promote some developmental training in bidding, estimating, and other procedures, or individual contractors could select a specific MBE and take him under his wing so to speak for training and development.

Attachment II

Special Provision for Minority Business Enterprise Training and Development

The special provision was developed several years ago as one approach to developing Minority Business Enterprise participation in Federal-aid highway construction. It has been used recently on a trial basis in one State for selected projects.

As you will note, the special provision sets up a bid item for reimbursement of MBE training and development costs accrued by prime contractors. The item is set up to be bid as a lump sum with a step or phase type of payment procedure. Payment under this item is contingent upon the prime contractor subcontracting at least $10,000 or 2 percent of the contract amount, whichever is greater, to an MBE.

The special provision may be adopted in its present form or modified as considered necessary. Several means of modification appear feasible such as: (1) removal of bid item provisions and requiring the work to be subsidiary to other items, (2) changing the minimum amount or percentage to be subcontracted, or (3) changing the percentages in the payment steps or the number of steps in the payment. We think that the three step payment as outlined should be the minimum number of steps, if the latter modification is to be considered.

Attachment III

Special Provision for Minority Business Enterprise Training and Development

Description. As part of the contractor's affirmative action responsibilities, the contractor shall make a concerted effort to train and develop minority business enterprises to become fully qualified contractors in the transportation facilities construction field. These efforts shall include at least the following:

The contractor will make every effort to solicit minority business enterprise subcontractor quotes and incorporate them into his bid for work on this project, by making systematic written and verbal contact with minority business enterprises likely to have an interest in transportation construction work. It is expected that a meaningful portion of the contract amount will be subcontracted to one or more approved minority business enterprises.

He shall also provide or arrange for direct assistance to the minority subcontractor(s) in such areas as preparing intelligent quotations, insuring that the minority business can read and understand highway plans, reaching a full understanding of the Standard Specifications applicable to the minority portion of the work, appropriate cost accounting and other business practices, and other actions aimed at continued development of the minority business into a viable highway contractor.

Evidence of the above actions shall be submitted by the contractor before any payment for this item is made.

The contractor shall maintain records and furnish periodic reports documenting his performance under this item.

The contractor shall pay the minority subcontractor on an accelerated basis, consistent with payment by the State, for this item of work.

Method of Measurement. Minority Business Enterprise Development will be measured as a single complete unit of work.

Basis of Payment. This item of work measured as provided above, will be paid for at the contract lump sum price for Minority Business Enterprise Development. This price shall be full compensation for soliciting, training, and developing minority subcontractors; maintaining records, furnishing reports and for supplying all facilities and services necessary to complete this item.

The contract lump sum shall be payable to the contractor in accordance with the following schedule:

No payment for this item of work will be made, if the contractor fails to subcontract at least $10,000 or two percent of the contract amount, whichever is greater, to a minority business enterprise.

For subcontracts let to minority business enterprises which equal or exceed the minimum set forth above, the contract lump sum shall be payable to the contractor as follows:

Fifty percent of the amount bid will be paid when the minority business enterprise commences work on the project.

Seventy-five percent of the amount bid will be paid when the minority business enterprise has satisfactorily performed one half of the work under the subcontract.

One hundred percent of the amount bid will be paid when the minority business enterprise has satisfactorily completed all subcontract work.

MINORITY CONTRACTORS IN HEAVY HIGHWAY CONSTRUCTION

By: SER- Minority Highway Contractors
Division
Austin, Texas

In 1976, the Texas State Department of Highways and Public Transportation awarded a contract to SER-Jobs for Progress, Inc., for the purpose of seeking the active participation of minority contractors in heavy highway construction projects throughout the State of Texas. SER-Jobs for Progress-Minority Highway Contractors in cooperation with the Texas Department of Highways, Public Transportation, and the Associated General Contractors-Highway Heavy Branch, has developed goals to provide comprehensive technical assistance throughout the State of Texas to minority contractors. This insures that minority contractors are afforded every opportunity to qualify, bid, and receive Texas Department of Highways and Public Transportation contracts.

In order to enhance the program's effectiveness, efforts to seek and identify minority contractors have been concentrated in areas having the largest number of such contractors. These areas include Corpus Christi, Dallas-Fort Worth, El Paso, Houston, San Antonio , and the Rio Grande Valley.

SER's concept is to work with a limited number of clients and provide adequate assistance rather than work with a large number of clients, which could sacrifice the quality of assistance given.

The objective of the program is to establish a strong base of minority contractors involved in highway construction throughout Texas. Comprehensive technical assistance and information is provided to our clients through frequent visits made to various Texas cities. The program staff explains the various opportunities available in highway construction, as well as the methodology and paperwork required when performing work for the Texas State Department of Highways and Public Transportation.

This office helps the contractor formulate and carry out his plan to successfully bid on highway projects. Information is gathered from suppliers of materials needed to complete a job, and the client is also provided with a complete safety package to enable him to comply with OSHA regulations.

Some of the services provided thru the program include the assistance in preparing required forms for "Bidders Questionnaire" and/or "Pre-Qualified" contractors. Also, an active and current list of minority contractors is maintained to facilitate interaction between minority contractors conducive to joint ventures.

The establishment of contact with Prime Contractors to enable clients to submit subcontract bids with minimal difficulty is emphasized. Coordination of efforts with Federal, State, and local agencies to provide maximum assistance is stressed also. Data on bidding techniques and analyses of trends or innovations in the highway construction industry are made available to interested clients.

The progress of clients, once they have entered the mainstream of highway construction, is followed in order to gauge progress and inform them of law revisions, district project lettings, and other information pertinent to the highway industry.

Seminars are scheduled when necessary in order to address groups of contractors at a time. On a larger scale, conferences are held annually providing interaction between minority contractors and AGC members throughout the State. Discussion of mutual problems and how they have been resolved is promoted. Recently, a "Conference for Minority Highway Contractors" was held in Austin. Response from the 22 attending clients was quite favorable in regards to the contents of the discussions and presentations. Representatives from five AGC firms discussed their respective company's subcontracting procedures and policies. Presentations were made by officials from the Texas State Department of Highways and Public Transportation and also by the Associated General Contractors of Texas. A local insurance agent discussed bonding and insurance requirements. In concluding the conference, the staff of SER-Minority Highway Contractors Division provided the clients with an outlook of projects of interest to be let in the future.

SER-Minority Highway Contractors Division has recently instituted a new program designed to assist Texas minority contractors in establishing effective accounting systems. History reveals that proper recordkeeping, job costs, and use of internal and administrative controls enhances the ability of a construction firm to succeed.

The steps involved in this Accounting Services Program are:

1. SER-Minority Highway Contractors Division contracts with a Certified Public Accounting (CPA) firm to provide accounting and managerial advisory services to a minority contractor. The CPA firm is usually located in the same city as the minority contractor being served.

2. The CPA visits the contractor and conducts an initial survey to determine the adequacy of the accounting system with emphasis on the following:

    a. books of original origin,
    b. general ledger,
    c. double-entry accounting,
    d. payroll and payroll tax accounting,
    e. job costing,
    f. subsidiary ledgers (receivables, payables, etc.)
    g. internal and administrative controls.

3. Upon review of the initial survey, recommendations for improvement of the contractor's existing accounting system are developed by the CPA. These recommendations are thoroughly explained to the contractor so that he can understand how they are beneficial to his company and its growth.

4. The recommendations are submitted to the contractor and to SER-Minority Highway Contractor Division. The contractor must then either accept or reject the CPA's recommendations. If they are rejected, SER's contract with the COA is terminated at this point. If they are accepted, the process continues into the implementation state.

5. Upon acceptance by the contractor, the CPA proceeds with the implementation of the recommendations. Some of the recommendations that have been made by CPAs thus far are:

    a. establishment of subsidiary ledgers for accounts, payable and receivable,
    b. installation of job cost system,
    c. periodic cash flow analyses,
    d. monthly or quarterly financial statements,
    e. comprehensive tax planning,
    f. hiring a bookkeeper,
    g. implementation of a master chart of accounts to facilitate coping of transactions for adaptation to computerized processing,
    h. comparison of "bid estimate budgets" with actual expenditures.

6. Fifteen to thirty days after the improved accounting system has been installed, the CPA makes the initial recommendations. The initial recommendations shall then be evaluated to determine if any changes need to be made.

7. A final visit will be conducted by the CPA 15 to 30 days after the followup visit. The same procedures will be applied as in the followup visit. However, at the end of this visit a final report will be submitted.

Although the Accounting Services Program is relatively new, the results received thus far have been very favorable. Once an effective accounting system is implemented, the minority contractor has a very valuable decision-making tool at his disposal. He can use this vital source of management information to improve operational efficiency, maintain effective control of his business, and to plan for controlled growth of the company.

The assistance that SER-Minority Highway Contractors Division delivers to minority contractors will ultimately achieve the goal of firmly establishing its clients in the highway construction industry.

November 1977 thru July 1979

$3, 363,453	Total Amount of Bids by MBE's in Highway Construction
$1,192,451	Total Amount Awarded to MBE's in Highway Construction

MINORITY BUSINESSES IN HIGHWAY CONSTRUCTION IN MARYLAND

By: Jo Paylor
Equal Opportunity Specialist
Maryland Division
Federal Highway Administration
U.S. Department of Transportation

INTRODUCTION

For FY 1978, Maryland State Highway Administration awarded more than $23 million in contracts and subcontracts to minority firms, more than 10 percent of all contracts valued at $100,000 or more. These figures placed Maryland first in the country and were the results of close coordination and cooperation between Federal, State, and local authorities. Quarterly reports for FY 1979 indicate continuing success in this area.

BACKGROUND

Since the issuance of Executive Order 11625 in October 1971, the Federal Highway Administration (FHWA) has promoted participation of minority firms in highway construction. In 1975, States were required by FHPM 6-4-1-8 to take affirmative actions to increase minority involvement by:

1. identifying minority firms interested in working on Federal-aid highway projects,
2. requiring low-bidders to indicate plans to subcontract or not to subcontract, and
3. requiring contractors to affirmatively solicit minority subcontractors if any subbing is done.

Until mid 1977, minimal success was recorded Nationwide. Spurred by Executive mandate, renewed agency commitment and much public interest, each DOT-FHWA administering level reviewed its past practices and sought new methods to achieve minority participation in highway contracting.

MARYLAND's MBE PROGRAM

After months of drafting and redrafting, the Maryland State Highway Administration and the Interstate Division of Baltimore City (IDBC) adopted new MBE contract provisions for projects of $100,000 or more.

MINORITY BUSINESS ENTERPRISE UTILIZATION
AFFIRMATIVE ACTION CERTIFICATION

(This document and its requirements
shall be applicable where the
Contractor's bid exceeds $100,000.)

In connection with the above numbered project, I hereby certify that

I am the ______________________________ and duly authorized representative
(Title)

______________________________ whose address is ______________________________.
(Firm)

I do hereby certify that it is the intention of the above organization to affirmatively seek out and consider minority business enterprises to participate in this contract as subcontractors and/or suppliers of materials and services.

I understand and agree that any and all subcontracting in connection with this contract, whether undertaken prior to or subsequently to award of contract, will be in accordance with this provision. I also understand and agree that no subcontracting will be approved until the State Highway Administration has reviewed and approved the affirmative actions taken by the above organization.

As used in this contract, the term "minority business enterprise" is defined in Section 10.01-1.

The utilization of minority business enterprises is in addition to all other equal opportunity requirements of this contract.

1. Action Required by Contractor:

   The contractor shall, as a minimum, take the following actions to assure full opportunity to minority business enterprises:

   a. Develop and submit for approval, before award, no later than 14 days after bid opening, an affirmative action plan for a Minority Business Enterprise Program which will include as a minimum:

      (1) Appointment of a representative to administer the Contractor's Minority Business Enterprise Program.

      (2) Establish a goal of awarding 10 percent of the total contract value to subcontractors and/or suppliers which qualify as minority business enterprises.

(3) An explanation of affirmative action methods intended to be used in seeking out and considering minority business enterprises as subcontractors or suppliers. It is recommended that this affirmative action begin as early in the bidding process as possible, preferably before proposals are submitted to the State Highway Administration.

(4) A list of qualified minority business enterprises to be utilized during the performance of the work, including:

(a) The name of each subcontractor or supplier and an explanation of how each conforms to the definitions of a minority business enterprise;

(b) The type of work to be performed by each subcontractor or supplier; and

(c) The percentage of the total contract value to be performed by each.

b. In the event that the cumlative percentages listed in subparagraph 1.a.(4) above do not equal or exceed the goals of 10 percent of the total contract value, the submission shall include a request for an exception of the goal to the degree that qualified minority business enterprises are demonstrated to be not available. Evidence in support of the request for exception must accompany this request.

c. Failure to comply with this section will result in rejection of the contractor's bid.

d. Should an exception be granted as provided in subparagraph b. above, and the contract awarded, the contractor will continue to pursue his goal established in subparagraph 1.a.(2) above in connection with all actions involving subcontracting and/or procuring materials and services during the life of the contract.

2. Records and Reports

a. The Contractor shall keep such records as are necessary to determine compliance with its Minority Business Enterprises Utilization obligations. The records kept by the contractor will be designed to indicate:

(1) The number of minority and non-minority subcontractors and suppliers and the type of work or materials or services being performed on or incorporated in this project.

(2) The progress and efforts being made in seeking out minority contractor organizations and individual minority contractors for work on this project.

(3) Documentation of all correspondence, contacts, telephone calls, etc., to obtain the services of minority business enterprises on this project.

b. Submit reports as required by the Administration, but at least on a quarterly basis of those contracts and other business executed with minority business enterprises with respect to the records referred to in paragraph 2a above in such form and manner as prescribed by.

c. All such records must be maintained for a period of three years following acceptance of final payment and will be available for inspection by the State Highway Administration and the Federal Highway Administration.

I acknowledge that this Certification is to be made an integral part of the proposal form for the above numbered project.

____________________ (date)

____________________________________ (signature)

Sworn to and subscribed to before me this ____________ day of

________________________, 19____.

____________________________________ (NOTARY PUBLIC)

My commission expires _______________

COMMENT

Section 1.B provides for exceptions from the goal. Requests for such exceptions are reviewed by States' in-house evaluation committee. An example of situations in which a low-bidder could not equal or exceed the established goal might be:

> A single or limited item contract such as patching, signing, or traffic striping which is more than $100,000 but does not lend itself to subcontracting. Further, the location may be a geographical area not accessible to MBE's.

These type situations and countless other combinations of circumstances are examined by the in-house (SHA/IDBC) committees on a project by project basis to determine the acceptability of the Affirmative Action Plan.

PROBLEMS

The first few contracts containing the revised specifications met with objections concerning questionable minority identification. State and local procedures for investigating claims of minority ownership led to the establishment of the Maryland Department of Transportation Minority Business Enterprise Advisory Committee. This group is composed of representatives from minority and majority contractor associations, civic organizations, and State transportation agencies. It examines internal operations, corporate structure, and various other factors which would indicate true ownership or control. If after studying and evaluating the necessary data, minority ownership is evident, the committee recommends certification, if not, denial of certification is recommended. The final determination rests with the State SEcretary of Transportation.

Another problem experienced during the first year was extreme delay caused by processing each MBE Affirmative Action Plan. Many times the low-bidder's initial submission showed a need for assistance in obtaining sufficient participation.

Some of the deficiencies in the initial plan may be caused by the low-bidder:

1. not soliciting minority subcontractors,
2. not soliciting from a wide universe of minority contractors,
3. not providing minority firms adequate information to evoke an interested response,
4. not appointing a company MBE representative.

These are some of the reasons a low-bidder may be requested to revise its' affirmative action plan. Revision and resubmission of the plan sometimes require time extensions and thus cause Maryland to exceed its normal 60 day award limitation.

The above listed shortcomings do not necessarily depict most submissions, rather in many instances low-bidders use innovative thinking and non-traditional methods to involve minority participation.

Resolution of these and other problem situations have brought Maryland Division and State officials to a new stage in MBE program implementation. Minority firms have been identified and are systematically included on highway construction projects. Where do we go from here?

DEVELOPMENT

Many minority companies desiring highway work have been successful in other endeavors but have little experience in highway construction. To them the intricacies of the industry are new and confusing. Maryland has assumed some of the responsibility for training and developing such firms. Using FHWA Supportive Services/MBE funds the State will provide seminars, workshops, and technical assistance to interested small and minority companies.

SUMMARY

Over the past two fiscal years, Maryland has been in the forefront of accomplishment in the Minority Business Enterprise Program. Involved Federal Highway Administration officials (Headquarters, Region, and Division) have worked diligently with State and local personnel as well as with minority and majority contractor representatives to promote equity in Federal-aid highway contracting. The more than $40 million awarded to minority firms since the inception of the MBE Affirmative Action requirements reflect first stage results. Having been successful in bringing MBE's into the industry, Maryland has expanded its program to include supportive and developmental assistance. These steps, Federal regulations, and local support are key elements in retaining the high level commitment necessary to assure continued progress.

ILLINOIS MINORITY BUSINESS ENTERPRISE PROGRAM

By: Illinois Department of Transportation
Springfield, Illinois

The Illinois Department of Transportation (IDOT) has long been active in utilizing Minority Business Enterprises (MBE) in highway construction. The Department's first experience with minority contractors occurred in 1968, when two minority contractors were awarded six subcontracts at a total of $38,145. The MBE program grew rapidly to a peak in 1976, when 41 different minority contractors were awarded 11 prime contracts and 140 subcontracts, for a total of $7,782,047. A reduced total highway program and a program to eliminate firms which were not bona fide MBEs diminished the Department's MBE participation after 1976.

In 1968, Federal highway funds were cut off from Madison and St. Clair counties in Illinois; the Greater East St. Louis area. This action by the Federal Highway Administration (FHWA) was taken because of a lack of minority utilization and the high cost of construction. A "Hometown Plan" agreed to by contractors, unions, and the minority community, and approved by the IDOT and FHWA, provided a basis for release of FHWA funds in 1970. East St. Louis has a population of 69,996, of which 69.1 percent are black.

In 1972, IDOT negotiated three construction projects in East St. Louis with three minority contractors. Each had the understanding that they would subcontract work to other available minority contractors. The three contracts amounted to approximately $750,000. This action alerted the industry and the minority community that IDOT was sincere in its MBE program.

In 1975, IDOT implemented two programs to promote the further utilization of minority contractors: a set-aside program and a technical assistance program to provide one-on-one assistance to minority contractors.

Starting with the May, 1975 letting, a special provision was included in selected contracts requiring a designated percent of the contract value to be performed by minority contractors. Only those contracts that have a wide variety of work, portions of which can be performed by minority contractors, and are located in areas of known minority contractors, are selected for the set-aside provision. The normal set-aside is two percent, but has varied from one to four percent. One contract now scheduled for the reconstruction of the main expressway circle interchange in Chicago has a five percent set-aside.

During 1978, a total of 814 contracts were awarded by IDOT, 44 of which included the set-aside provision. Compliance by the contractor is based upon the amount of money paid to the MBE for work subcontracted.

In 1976, the Associated General Contractors of Illinois filed suit against IDOT over its use of the set-aside special provision. The decision was awarded to IDOT. However, the consent decree prescribed relief measures for contractors. Pursuant to the consent decree, a contractor may request a modification or waiver of the special provision at or before the preconstruction conference. The request must be in writing and be accompanied by supporting information, indicating why the special provision should be modified or waived. At any time during the life of the contract, if the general contractor claims a material breach of contract by a minority contractor, which would impair the general contractor's ability to comply with the special provision, the general contractor may request a modification or waiver.

Another relief measure provided by the consent decree was that the general contractor may request IDOT to locate minority contractors to perform the required set-aside work. If IDOT cannot locate such minority contractors within 15 working days, IDOT is required to modify or waive the special provision.

Finally, there is a hearing process after the completion of the contract where a general contractor who has failed to meet the set-aside goal may present evidence as to why sanctions should not be imposed.

After four years of utilizing the set-aside special provision, no general contractor has officially requested IDOT to locate a minority contractor. No general contractor has asked for a hearing at the completion of work and only two general contractors have had final payments reduced for failure to subcontract the required amount of work to minority contractors. Two other contractors failed to achieve the required minority contractor participation. However, due to reduction in quantities of subcontracted items, IDOT waived the penalty. Such results are considered a success, considering IDOT has awarded 193 contracts with MBE set-aside provisions in four years of operation.

As a complement to the set-aside program, IDOT initiated a technical assistance program for small and minority contractors. In 1975, IDOT reuqested the Illinois Office of Minority Business Enterprises (IOMBE) to provide management and professional engineering assistance to small and minority contractors who were interested in doing highway work for IDOT or building work for the Illinois Capitol Development Board. The program consisted of a series of seminars, followed by one-on-one assistance to small and minority contractors at their offices or job sites

In 1977, the FHWA allocated $172,400 to Illinois for MBE supportive services. With these funds, IDOT entered into agreements with two private consultants to provide technical assistance to small and minority contractors. These consultants were: Mr. H. John Sorensen, P.E.; and the Chicago Economic Development Corporation, Contractors Division (commonly known as CEDCO).

Mr. Sorensen operates as a one-man consulting firm and devotes approximately half of his time assisting small and minority contractors for IDOT. He is a graduate of the University of Illinois with a B.S. Degree in Civil Engineering. Mr. Sorensen worked for IDOT for 26 years in various capacities including six years as Chief Estimator for IDOT. He provides highly professional assistance to small and minority contractors in the area of bidding, estimating, plan reading, job management, job records, construction problems, etc. Two associates with wide construction backgrounds are available to Mr. Sorensen on an as-needed basis.

CEDCO Contractors Division, a Division of the Chicago Economic Development Corporation, offers a full range of services to small and minority contractors free of charge. The CEDCO is funded by various governmental agencies in the Chicago area and is in its ninth year of operation. The IDOT's contract with CEDCO provides for management assistance to contractors on a statewide basis and complements the professional engineering services provided by Mr. Sorensen. These services include: advice and assistance in bonding, financing, contract procurement, liaison with general contractors and awarding agencies, office management and record keeping, legal matters, cash flow, capability analysis, etc., other than its scope to general Chicago area. Two specialists of CEDCO are assigned to work with IDOT contractors.

The CEDCO has been developing viability profiles on as many minority contractors as time permits. This profile is a summary of a contractor's ability to perform, including size and type of jobs, number of jobs at one time, limit of bonding (if bondable), geographical area of activities and general comments. This information is used by IDOT as a basis for establishing MBE goals and determining set-aside requirements.

The IOMBE is also under contract with IDOT to provide assistance to small and minority contractors who are interested in performing highway work. The IOMBE has assigned two specialists to the IDOT program.

The IDOT also has two minority Contractor Liaison Officers on the State Equal Employment Opportunity Staff.

Technical assistance provided by IDOT is targeted toward full assistance and routine followup to a limited number of small and minority contractors.

Contractors must request assistance and be willing to cooperate before they are taken on as clients. There are occasions, however, when a contractor will request assistance for a one-time problem and will be given assistance. All requests for assistance must be cleared through the Central EEO Office in Springfield, Illinois.

The IDOT feels that the only way a technical assistance program can be successful is to provide the highest caliber professional personnel available. Months or years are needed to establish a rapport with minority contractors to a point where they will trust the specialists with the details of the operations of their firm.

Technical assistance not only helps the small and minority contractors, but also is valuable to general contractors and IDOT construction personnel. If problems arise on a job, assistance is available to help the MBE at a meeting with the general contractor and/or IDOT construction personnel.

Of concern to IDOT is the lack of bidding as prime contractors by the minorities. During 1978, 883 contracts were awarded by IDOT. Of those only 21 bidding documents were taken by minority contractors: 15 bids were received, and only six awards made to two minority contractors. Of the 883 jobs advertised for bidding, approximately 40 percent had a value under $150,000.

The IDOT has, for the past seven years, attempted to advertise jobs that are compatible with the abilities of minority contractors. In several instances, contracts have been broken into small units to encourage minority bidding. The results have not been encouraging.

Basic highway construction consists of grading, concrete paving, structures, stone surfacing, and hot-mix surfacing all with the related items of landscaping, signing, electrical, etc. The cost of equipment usually precludes minorities from engaging in the basic construction. Most minority contractors doing highway work have a background of building construction or remodeling. Most are neither equipped nor experienced in the basic highway construction fields and, therefore, pursue the related work which generally falls into the subcontract items.

With these conditions existing, IDOT is attempting to create an environment that is favorable for minority contractor growth in the basic highway area. It is felt that the implementation of highly professional technical assistance is a giant step in the right direction. In order to further improve the favorable growth environment, additional steps have been taken. The IDOT has recently included in all awarded contracts, a special provision which permits a contractor to include a mobilization cost item up to six percent of the total bid. Ten percent of the pay item for mobilization is payable upon execution of the contract: 30 percent of the pay item is payable when five percent of the work is completed; 20 percent of the pay item is payable when 10 percent of the work is completed; and the remainder of the pay item is payable when 25 percent of the contract work is completed.

Prequalification requirements have been modified to permit a contractor to be prequalified up to $150,00 based upon an unaudited financial statement or, in lieu of a financial statement, a signed certificate by a surety stating the maximum amount of performance bond the surety will provide on bahelf of a contractor. This certification may be for a specific job or for a specific period of time. Prequalification for subcontractors has never been required by IDOT.

The IDOT has for many years required a 10 percent bid deposit in the form of a bank draft, bank cashier's check or certified check. The amount of bid guarantee is being reduced to five percent and provisions are being made to accept a bid bond in lieu of a bid check.

Also, IDOT has for many years held retainage from contractors in the amount of 10 percent until 50 percent of the contract work is performed. No further retainage is held unless there is work added to the contract. Steps are being taken to reduce retainage to two percent for the life of the contract.

It is hoped that minority contractors will be in a better position as a result of these new procedures.

In January 1978, a notice was published to all prequalified contractors that IDOT intended to review minority firms to determine if any were not bona fide. Only those minority firms that are bona fide will be included on the list prepared by the Department.

As a result of the notice and subsequent reviews, approximately six "minority" firms were dropped from the Department's Minority Contractor List. Since that time, all new firms added to the list are investigated and approved before the name is added.

The botton line of IDOT's MBE Program is to provide opportunity for minorities to get into the mainstream of highway construction. The IDOT is attempting to create an environment which is favorable to the formation and healthy growth of minority contractors. Spectacular results are not expected. Slow, but steady growth is expected.

ENGLEWOOD
CONSTRUCTION COMPANY
CHICAGO, ILLINOIS
PHONE (312) 994-2774

Eugene Anderson, Superintendent for Englewood Construction Company and IDOT's Resident Engineer, Ed Bartolameolli, on Edens Expressway Rehabilitation Project in Chicago, Illinois.

John White (left) and John Heard (right) of Imperial Trucking and Excavating Company, Springfield, Illinois, discuss the proposed highway work with Jack Sorensen (center), Technical Assistance Consultant for IDOT.

C.D.S
CONSTRUCTION INC

Bill Chapman, President of CDS Construction and J.L. Bradley Financial Analysis Manager, CEDCO, review plans on Edens Expressway.

Bill Chapman, President of CDS and J. L. Bradley, Financial Analysis Manager, CEDCO, look on as CDS crew places catch basin into position on Edens Expressway.

COLORADO MINORITY BUSINESS ENTERPRISE

By: Colorado Department of Highways
Denver, Colorado

Minority Business Enterprise (MBE) participation in Colorado construction projects has been steadily increasing since the implementation of the MBE Supportive Service Contract in 1976. The dollar amount awarded MBEs has risen from 1.0 million dollars awarded in the year previous to implementation, to over 4.5 million dollars in the present fiscal year.

The main reason for the success of the program is a technical staff that spends 100 percent of the time working directly with MBEs on a one to one basis. The staff consists of a project engineer, administrative assistant, and secretary. The engineer has highway construction experience and the administrative assistant has experience as a liason between the office and the minority community. There also is support from the Division of Highways, which includes an E.E.O. Supervisor, an E.E.O. coordinator, and six E.E.O. representatives located throughout the State for assistance.

The basic services provided for Minority Contractors by the Supportive Services Contractor includes:

1. Identification of minority contractors who are interested and capable of handling highway construction.
2. Identification of prime contractors involved with the Colorado Division of Highways and the type of work they normally subcontract.
3. Assistance in completing prequalification forms.
4. Identification of highway projects which contain work that Minority Contractors can become involved.
5. Technical assistance for site investigations, estimating, scheduling, pre-construction meetings, bid proposals, and post-award information.
6. A referral system identifying subcontract opportunities for Minority Contractors and referring qualified minority subcontractors to prime contractors requesting same.
7. Training seminars designed to provide minority contractors with methods of pre-bid estimating, bidding, bonding, prequalifications, construction accounting, and construction management.
8. Sources for other assistance such as financing and equipment procurement.

The Colorado Division of Highways efforts include such strategies as:

1. Reduced Prequalification Requirements

   Contractors may become prequalified for any project up to $250,000 without a certified public accountant statement. This is an increase from $100,000.

2. Smaller Construction Projects

   The department is now developing smaller projects which are more suitable for small business firms.

3. Affirmative Action in Subcontracting

   The department requires prime contractors to show a good faith effort in obtaining minority subcontractors. The department's approval of subcontracts is contigent upon Division of Highways form 205, which must verify a good faith attempt to locate minority subcontractors for the work requested for subletting.

4. Field Personnel

   The department has E.E.O. Representatives located throughout the State to assist Minority Business Enterprises with on the job documents and forms.

Plans for every Colorado Division of Highway Projeft are analyzed by the project engineer. The plans are then filed in the office until bid date.

Appropriate minority contractors are solicited by letter and/or phone to bid on:

1. the entire project as a prime contractor and

2. subcontract opportunities in the contractor's specialized field.

If the contractor wishes to bid and requests assistance, the project engineer aids with take-offs, pricing, estimating, and bid preparation. This assistance deals with methods and procedures and does not provide a total bid price.

The office represents the contractors interests at site investigations, pre-bid conferences, award conferences, and pre-construction meetings. Seminars and workshops are presented to resolve problems encountered by the minority contractor in the highway construction field.

The Supportive Service contractor maintains an ongoing relationship with various task force committees and minority organizations to insure a more viable program. This aids in the development of programs insuring minority contractors assistance in overcoming barriers to program particiaption.

The majority success in increasing minority participation has been achieved by placing minority subcontractors with prime contractors. Ninety-five percent of the contractors utilizing the services offered are small businesses. Many are participating in highway construction for the first time. These smaller contractors deal in specialized areas such as landscaping and fencing rather than general construction.

Subcontracting opportunities are smaller in volume, enabling a minority contractor to obtain bonding more readily. In some instances the bond is waived by the prime contractor. Also, the cash flow needed to perform smaller jobs is not as great, thus a minority contractor need not tie-up limited cash for long periods of time.

Subcontracts give the minority contractor the means to establish procedures dealing with government forms. Many contractors shy away from the paperwork involved with government contracts. By starting as a subcontractor, the minority contractor can gain experience from completing a limited number of forms.

With the adopted policy of the Colorado Division of Highways developing smaller projects, prime contracts are beginning to deal solely with fencing, landscape, or concrete. Subcontractors can now graduate to become small prime contractors and, in turn, grow into large prime contractors. It is not an overnight success story. It takes time to develop, maintain, and improve a minority contractor to the point where he can bid a million dollar project and complete it successfully. In Colorado, the process has begun.

WISCONSIN'S MINORITY BUSINESS ENTERPRISE

By: Phillip H. Decabooter
Assistant Contracts and Estimates Engineer
Wisconsin Department of Transportation
Madison, Wisconsin

Introductory Remarks

Wisconsin has a diverse minority population. There is a high proportion of Black people in the industrialized Milwaukee standard area, a number of native American enclaves and reservations stretching from its near north counties to the Upper Peninsula and Northern Minnesota borders and a broad dispersion of Hispanic individuals throughout most of its geographic area.

According to the latest statistics prepared by the Wisconsin Department of Industry, Labor, and Human Realtions, the total population of Wisconsin is somewhat more than 4.5 million. Its ethnic minority population stands as about 250,000 people or roughly 5.5 percent.

For a number of years, the Wisconsin Department of Transportation has maintained a strong affirmative action stance in order to bring about sufficient involvement of ethnic minority people in its highway construction program. Recognizing that contracting itself is a very effective conduit for production of income in highway construction work much recent attention has been focused on Wisconsin Minority Business Enterprise (MBE).

Since Wisconsin's minority contingent is relatively low, and concentrated mostly in Milwaukee, obtaining representative involvement of Minority entrepreneuers in an annual construction program exceeding one hundred million dollars presents some unique challenges. In addition, most Wisconsin MBE's have to be developed even before they would be able to bid for meaningful portions of the program.

What We've Tried Before

In the years prior to 1978, Wisconsin's approach in attempting to increase MBE involvement was one of constant encouragement (to-the-point-of-coercion of non-minority primes to sub out work to MBE).

Our agency personnel also tried numerous methods to interest MBE's in prequalifying with our agency and then bidding on subsequent construction jobs. Despite a great deal of effort along these lines, there was a lack of response. Part of this was attributed to MBE's being unsophisticated in bidding processes. There was a growing belief that lack of sufficient monetary commitment by D.O.T. to compensate for potential losses and uncertainties might also be a significant factor. To be sure, increasing emphasis was boosting MBE participation, but not to a satisfactory level.

On March 27, 1978, President Carter directed all Federal agencies to triple Federal contracting to MBE's from year earlier levels. The Federal Highway Administration issued a March 6, 1978, mandate requiring all State contracting agencies to draft and implement an MBE action plan pertaining to Federal-aid highway work.

In late July and early August, 1978, then-Wisconsin D.O.T. Secretary Dale Cattanach conducted five evening meetings with non-minority prime contractors throughout the State. The purpose of these was to ascertain contractor concerns about this program while supporting and emphasizing it. Shortly after the conclusion, Wisconsin developed its Action Plan, the main thrust of which is to reach about two percent MBE involvement in Wisconsin's 1979 highway construction program.

Precepts of the Plan

At the series of meetings previously mentioned, a number of contractor concerns were brought forth. These and our agency's concerns were addressed in eight major comments to action:

1. We would grant time extensions to any contractors who ran into overtime only because of their efforts to involve a minority enterprise.

2. We would give first priority to processing pay estimates on projects on which a minority subcontractor is participating.

3. We would rapidly reduce retainers on projects involving minority subcontractors.

4. A major element was the inclusion of an MBE development item in contracts which would have the best prospects for supporting such efforts. A contract special provision was developed in response to this item and will be explained further in this text.

5. We encourage the Wisconsin Road Builders Association to form a steering committee to develop methods by which Wisconsin contractors can communicate and deal with MBE's.

6. We are splitting off and advertising small contracts, which we believe are within the capabilities of minority contractors whom, we're aware, would not require prequalification.

7. We have met and will continue to meet with any interested MBE's in an attempt to kindle their interest for furnishing serious quotes as subcontractors or prequalifying with our agency for bidding as prime contractors. We have scheduled "pre-bid meetings" for jobs not requiring prequalification. We encourage would-be minority bidders to attend so we can provide information and detailed instructions for assisting them in formulating their bids.

8. We have petitioned all Surety companies traditionally doing business in Wisconsin for their support in circumventing bonding difficulties often experienced by MBE's.

This action plan was designed to be fully implemented before the beginning of the 1979 construction season. In fact, we had initiated action in all eight areas well before the end of the first quarter of 1979.

One of the main operating elements of the action plan was the MBE Development Special Provision. It was designed expressly to be included in contracts over $500,000 having enough diversity to support MBE involvement for two percent of the total value of the contract. Wisconsin D.O.T. is adverse to specific set asides which this scheme appears to resemble. It differs in one important respect. In exchange for a prime contractor subbing out two percent or more of any contract to MBE's, we have included a bid item to compensate the contractor for costs incurred in these development efforts. The item is open ended, so the contractor can bid whatever he feels is justified to sufficiently involve MBE's.

There are three advantages to using this method:

1. It preserves the competitive aspect by allowing each contractor to bid true costs.

2. It tends to reward those contractors who had developed MBE contracts before they were recompensed. Presumably this allows them to fulfill their MBE contract obligation at lower cost, thus yielding an enhanced bidding position.

3. By assigning MBE's to an array of projects, the tendency to develop only one kind of contractor (e.g. landscapers) can be avoided.

Hence one group of ono-minority contractors shouldn't be overburdened by excessive competition while heavily favoring only one sector of MBE's.

Performance to Date

Comparing results to date for 1979 (includes the dollar value of all jobs let through June 19, 1979) with first half 1978 results, we note the following:

Year	No. of Private Contracts Let for First 6 Months	No. of Reported Prime & Sub-contracts to MBE's	$ Value All Contracts	$ Amt. of Const. Contracts To MBE's	%
1978	199	14	$ 88,649,707	$321,165	0.36
1979	226	23*	124,264,422	537,485*	0.43*

* Does not include the effect of the entire June letting and part of the May letting.

While there has been only a slight increase between the first half of this year compared with the same 1978 period we anticipate substantial improvement as the jobs so far assigned MBE development all begin to come on line. Most of the June projects' results won't show up in our statistics until approximately mid-August. The estimated amount of subcontracting requirements yet to be reported for May and June are $312,500. This brings the MBE contract work awarded or previously allotted to 0.68 percent. Additional MBE contracts are generally struck through the remainder of the season. Since the greatest percentage of our work has now been let, we expect to approach our initial goal based on observations of the previous years' occurrences.

Conclusion

Since this is the first year of our program to heavily involve MBE's and to stand good for costs incurred, it is difficult to precisely predict the outcome of our efforts. Early indications seem positive. Wisconsin D.O.T.'s Minority Business Enterprise program is backed up by strong top management support, rigorous enforcement, and surveillance, and the excellent cooperation of the Wisconsin Road Builder's Association.

Our agency is hopeful we have taken some strides toward breaking down barriers to MBE participation in Wisconsin's highway construction program.

MONTANA MINORITY BUSINESS ENTERPRISE PROGRAM

By: Montana Department of Highways
Helena, Montana

The Montana Department of Highways Minority Business Enterprise Program is operated with Supportive Service Contracts in conjunction with the Federal Highway Administration. The Department of Highways principal supportive service contract is with the Montana Contractors Association. This contract has been most successful, due to the continuity of the program. Mr. Larry Moore, MBE coordinator for the Montana Contractors Association and Ms. Peggy M. Dolan, MBE Compliance Officer for the Montana Department of Highways, work very closely in seeking out and identifying potential MBE's for work on Federal-Aid Projects. This involves developing a communication center for use by the highway agency and the MBE's, conducting seminars and workshops, and providing professional assistance where needed. The Montana Contractors Association provides available office space and a Plans bulletin room, where the MBE's may study plans prior to submission of bids. We feel that our combined efforts have been most fruitful.

Quarterly meetings are held with the Federal Highway Administration, Equal Employment Opportunity Complaince Officers, the MBE Compliance Officer from the Department of Highways, and the Supportive Services Contractors.

At these meetings all problems that have developed are aired by the aforementioned personnel, and solutions sought in their correction. New ideas are formulated, discussed,and adopted to improve the program.

The first Minority Business Enterprise Seminar was held in the Montana Department of Highways auditorium, in 1978. We felt that this seminar was very successful in disseminating the necessary information to the MBE's, and our panel consisted of the finest professionals in their respective fields. However, we felt the attendance was not as good as it should have been. After a meeting with Mr. Gerald Eller and Mr. Don Fenton of the Federal Highway Administration it was decided to continue the seminars, but to hold them throughout the eleven divisions in the State. The purpose was to reach out in the areas where the MBE's reside, and to lessen the hardship, expense and transportation involved for these people to attend. Ms. Peggy Dolan, MBE Compliance Officer for the Department of Highways and Mr. Larry Moore, Montana Contractors Association's MBE Coordinator, set up the seminars in the respective areas. This has proven to be highly successful.

Personnel from the Department of Revenue, Small Business Administration, Bankers, Contractors, Bonding, Etc., attended these seminars. All facets necessary to start a business were covered by the above mentioned persons, with emphasis on a question and answer session. We emphasized informality at these seminars. This approach opened communication lines between the MBE's and the professionals who could provide needed assistance.

The Montana Department of Highways has compiled a directory, listing Minority Business Enterprise firms by categories of work. These categories include heavy highway, suppliers, specialties, gas stations, bulk plants, and professional personnel. We have added a specialty section, which does not deal strictly with highway work. This addition is to give assistance to all agencies desiring information concerning minority firms. Our directory is circulated to all contractors, all divisions throughout the State, city, county, Federal agencies, and any and all interested parties. The directory is updated periodically.

The Montana Contractors Association, through their Supportive Service Contract, have compiled an Office Manager's Manual. This manual covers all forms and general requirements necessary to the construction industry, and is most helpful to all contractors.

The Montana Department of Highways, through the assistance of the Federal Highway Administration's supportive services has secured a professional engineering consultant. This person has a varied background and knowledge of preparing bids, supplying information and assistance in bookkeeping procedures, advising the MBE's of the necessity of the forms for prequalification, licensing, bonding, and other pertinent information. This consultant is utilized only at the request of the MBE's, and as authorized by the Montana Department of Highways MBE Compliance OFficer. We have decided it is necessary to give personal assistance, on a one to one basis, to the MBE's because of paper work that is necessary in a competitive world of business.

The MBE Compliance Officer accompanies the MBE's, and introduces them to the personnel in charge of the prequalifications, licensing, Small Business Administration loans, bonding agents, etc. This personal assistance has helped MBE's overcome a great deal of fear and reluctance to pursue the necessary tools in becoming an active contractor, subcontractor, supplier and/or vendor. Our prime concern is to assist the sincere MBE's in their pursuit of a successful business endeavor.

The program has produced an MBE contractor this year that became prequalified, licensed, bonded, and has now been the successful bidder on two Federal-Aid Highway Projects as a prime contractor. Personal help was provided the MBE contractor by a local accounting firm and a bonding company in conjunction with the consulting engineer.

The draft shown below will help illustrate the progress and effectiveness of the Minority Business Enterprise Program of the Montana Department of Highways with the assistance of Supportive Service Contracts from the Federal Highway Administration. To date three Minority Business Enterprise contractors were successful bidders on Federal-Aid Projects, as Prime Contractors. We have 12 Minority Business Enterprise contractors prequalified with the Montana Department of Highways.

We feel the success of our program is due to the unselfish and complete dedication of the aforementioned personnel. Without their cooperation, our goals to develop successful MBE contractors could not have been achieved.

NEW JERSEY MINORITY BUSINESS ENTERPRISE PROGRAM

By: New Jersey Department of Transportation
Trenton, New Jersey

Minority groups and women in growing numbers are benefiting from the Minority Business Enterprise Program administered by the New Jersey Department of Transportation in public construction contracts which receive federal-aid money.

Mr. Paul Smith, Affirmative Action Specialist I, has been designated MBE Liaison Officer, for the New Jersey Department of Transportation, under the direction of Ms. Bonnie Watson-Carter, the Department's EEO Officer.

According to Mr. Smith, "The MBE Program was established in the Department in 1975, following a Johnson Administrative executive order. First, minority firms had to be identified and informed of the program. This was and is accomplished through a questionnaire sent by the EEO Office to the prospective MBE. Once it has been established that the firm meets the requirements as defined by the Federal government, as a "business that is owned and controlled by one or more minority persons, i.e., Black, Hispanic, Asian or Pacific Islander, American Indian, Alaskan Native, and more recently women regardless of race or ethnic origin," a personal review is arranged. Members of the EEO Staff visit the prospective MBE to ensure the validity of the questionnaire, by reviewing the corporate minutes, and stock certificates. The staff members also offer their assistance in trying to resolve any problems that the contractor may encounter. By use of the questionnaire, and the information obtained at the interview, a determination is made as to the MBE status of the organization. If the firm is approved, the vital statistics of that firm are incorporated into our MBE glossary. The name and address of the MBE also appears in the bidding material under the type of work performed by the organization. "Contractors submitting bids for DOT let projects were obligated to certify that they had made a good faith effort toward affirmative action, by contacting a required number of MBE's for the purpose of subcontracting." Mr. Smith indicated that revising the MBE list and adjustments to changing Federal requirements are never ending.

In June 1978, the MBE Program in New Jersey expanded to include specific goals for MBE participation. The minority utilization goal is included in each individual contract and states the percentage of the total dollar amount of award that must be subcontracted to minority contractors, or suppliers of materials and services. To monitor this program a goal committee has been developed. The goal committee consist of three standing members, one from each of the following; EEO Office, Contract Administration, and the Office of Compliance, as well as one from the originating Division.

Mr. Paul Smith has been designated Chairman of this committee. As Chairman of the Goal Utilization Program, Mr. Smith is obligated to implement the requirements of the Federal Highway Administration, the Urban Mass Transportation Administration, and the Federal Railroad Administration.

A prime contractor has seven days from the day of submitting his/her bid to submit an Affirmative Action Plan to the goal committee for approval. This plan must include as a minimum the following:

1. The name of the Liaison Officer to administer the Contractor's Minority Business Enterprise Program.

2. An explanation of affirmative action methods used in seeking out and considering minority business enterprises as subcontractors, material suppliers, or equipment lessors.

3. An explanation of affirmative action methods intended to be used in seeking out and considering minority business enterprises as subcontractors, material suppliers or equipment lessors. This refers to the contractors responsibility, i.e., Minority Business Enterprise/Affirmative Action activities after the award of contract and for the duration of said project.

4. A list of qualified minority business enterprises to be utilized during the performance of work, including:

    a. The name of each subcontractor, material supplier or equipment lessor, and an explanation of how each conforms to the definitions of a minority business enterprise.

    b. The type of work to be performed by each subcontractor, material supplier or equipment lessor by line item and dollar amount.

    c. The percentage of the total contract value to be performed by each.

In the event that the cumulative percentages do not equal or exceed the specified goal, the contractor shall submit a request for an exception of the goal. Evidence in support of the request for exception must accompany the request. Failure of the bidder to comply with this provision within the specified time or a reasonable approved extension thereof, will result in rejection of the bid. The contractor may further be declared ineligible for future Department contracts.

Since the implementation of this goal program, Mr. Smith cited the following statistics.

In 1977, (prior to the goal program) $155,571,723 was awarded in contracts of which $1,515,473 (1 percent) went to minority and female firms. The following year (of which only 6 months was subject to the goal program), $93,666,872 was awarded in contracts, with $3,182,047 (3.4 percent) subcontracted to minority and female organizations. During the first 2½ months of 1979, $32,329,714 was awarded and $2,186,266 (6.8 percent) was awarded to minorities and females. Even though the above statistics indicate the MBE program is moving toward its goal, only the first steps have been taken according to Mr. Smith. "Additional, MBE's must be found and, if necessary, helped to become eligible to compete for Government contract dollars, not only as subcontractor, but as prime bidders," he said, adding, "there must also be an ongoing evaluation and improvement of the system."

The EEO staff is currently in the process of computerizing the list of MBE's along with information concerning the MBE.

NORTH CAROLINA MINORITY BUSINESS ENTERPRISE INTERNSHIP PROGRAM

By: North Carolina Division of Highways
Raleigh, North Carolina

In the spring of 1974, the EEO Section of the North Carolina Department of Transportation, Division of Highways, recommended to the Small Business Administration in Charlotte that a conference be held to identify minority contractors who were interested in highway construction. Three months later a meeting was held at the SBA Office in Charlotte, North Carolina, with Mr. Chip Chase, now deceased; Cloyce Alford, DOT's Civil Rights Coordinator at that time; and EEO staff members Mr. James Rayford and W. A. Perry, Jr. Both Mr. Chase and the EEO staff members had the same concern - to identify minority contractors who wanted to become knowledgeable about highway construction. They agreed to exchange lists of minority contractors. This meeting was the first of numerous others that were held with the SBA until Mr. Chase's death early in 1975.

Of the minority contractors listed by the Small Business Administration, only four had been approved to perform highway work in North Carolina. In the meantime, contact was made with officials of Soul City, North Carolina, and a list of minority contractors was obtained from them. Soul City was the base of operation for the local OMBE office representing the eastern portion of the State. Their list had been compiled from information supplied by HUD and contained the names of contractors who were involved primarily in general construction. The lists were compared, and an effort was made to identify contractors who were equipped for highway construction.

In the fall of 1974, two officials from Soul City visited the EEO Office to identify minorities who could perform highway construction work.

In December 1974, representatives of the DOT Division of Highways, the SBA, Soul City, and minority contractors met at Soul City to continue efforts to identify more minority contractors and to inform minority contractors of opportunities in highway construction. Highway officials presented an overview of road construction plans for North Carolina, bidding procedures, qualifications, and other relevant information needed to secure contracts with the State.

Numerous other meetings followed, including some with representatives of both the Charlotte Business Resource Center (an OMBE funded organization) and the now defunct North Carolina Association of Minority Contractors (also in Charlotte).

As a result of continued efforts by the EEO Section, by the end of 1975, there were six minority contractors prequalified to perform work on construction projects and 28 approved minority subcontractors.

In 1976, under the Federally-funded Minority Business Enterprise Program, North Carolina entered into a three phase program with Management Manpower Associates, a minority firm located in Charlotte to develop and conduct a program designed to locate, identify, and help minority contractors become qualified highway construction contractors. The major thrust of the contract, funded through the Federal Highway Administration, is to identify those minority business enterprises that have the capability and potential of performing work on highway construction contracts and to assist interested minority contractors through training, counseling, education, contacts, etc., in competing for highway construction contracts.

Since the conception of the Minority Business Enterprise Program, the consultant and the EEO staff have attempted to solicit the interest and cooperation of the minority community. Most minority business enterprises that were previously involved in construction were involved in vertical (building) construction. Initially these showed little interest in highway construction, probably because they had no background in highway construction methods, were unsure of the availability of highway work, and/or were already involved in other Federally-assisted programs.

Prospective minority contractors face three major problems on highway construction work: (1) lack of experience and, therefore, lack of credibility with general contractors, (2) inability to secure bonding (the most significant), and (3) lack of sophistication in accounting, record keeping, estimating techniques, etc. The minority business enterprise contract is designed to attack each of these areas. The MBE consultant assists the minority subcontractors in obtaining bonding and provides formal training courses in; (1) estimating and bidding highway construction work, (2) accounting systems available that will best fit contractors involved in highway construction work, (3) record keeping requirements relating to payrolls, contract documents, etc., (4) how to read and use specifications dealing with highway construction and legal responsibilities and rights of contractors and subcontractors which should provide the basic business training needed prior to their becoming productive members of the highway construction community. The EEO staff visits all prime contractors on Federally-funded projects within two weeks after contracts are awarded to encourage minority consideration and to review provisions of the contract in connection with the MBE program. In the internship portion of the contract, a prime contractor and a minority contractor are paired in a "big brother" type of on-the-job training in highway construction. A side benefit to the training received by the intern is the improved communication and credibility gained by the prime contractor's personal knowledge of the minority contractor he helps to train. The potential in the minority community to effectively participate in highway construction is present, however, it must be sought out, interest must be stimulated, and some degree of training must be provided before this potential can be fully developed. If unreasonable MBE goals are imposed, there may not be a sufficient number of minority contractors to do the construction work at this time. North Carolina hopes to develop a reservoir of minority firms with solid foundations in training and experience that will enable them to survive and flourish in order to fill this void.

Listed below are total amounts of contracts awarded to minority firms for fiscal years 1976, 1977, 1978, and 1979.

1975-76	$2,063,143.80	(FHWA fiscal year)
1976-77	$ 997,228.00	(FHWA fiscal year)
1977-78	$1,171,613.55	(FHWA fiscal year)
1978-79	$2,777,824.97	(State fiscal year)

The two million dollar amount was reached during the fiscal year 1976 because of the large number of projects awarded due to the release of inpounded funds to the State during President Ford's administration, the number of projects ready to be let, matching funds being produced by the State, top state management's willingness to move the MBE Program forward, and the concerted effort made by the EEO Section to work with minority firms to assist them in becoming competitive highway construction contractors.

It is anticipated that the internship program will be the key to the ultimate success of North Carolina's MBE Program. The large measure of success experience since 1974 has been primarily due to the following:

1. The EEO Section was well established at an early date.

2. The EEO Staff works full time on MBE problems and is efficient in working with minority contractors and organizations.

3. The DOT-AGC Joint Committee's attitude toward the internship program is excellent.

4. A positive attitude has been displayed by all involved, including the Secretary of Transportation, the Administrator of the Division of Highways, the Manager of Construction, and the Head of Construction.

5. There has been total commitment by top management.

6. Top management meetings are held with prime contractors to convey the feeling that compliance is expected.

7. Assistance is given by the local Federal Highway Adminstration Office.

8. Minority firms are furnished notices to bidders for all projects.

9. The number of minority contractors attending lettings is increasing.

10. The MBE Consultant is present at the lettings and introduces minority contractors to prime contractors.

11. Minority contractors are permitted to go to AGC Offices in Charlotte, Raleigh, Greensboro, and Asheville to review and get prices from the prior month's letting.

12. There has been steady and improved communication between majority contractors and minority contractors.

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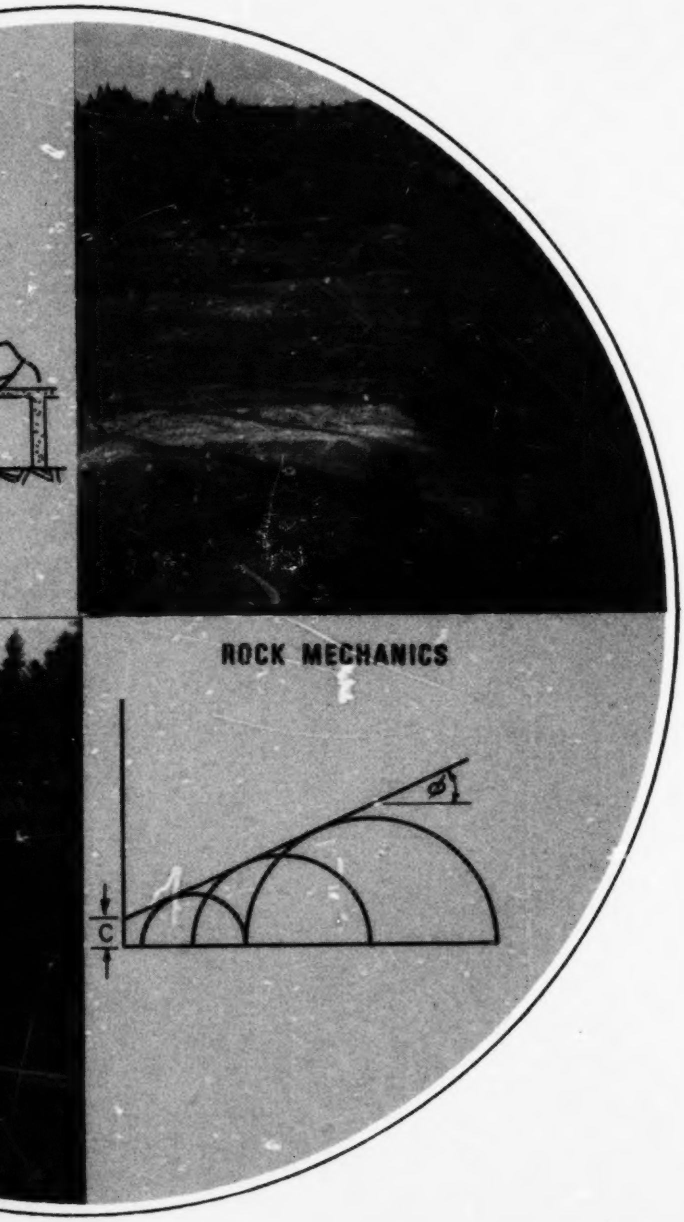
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FOREWORD

This issue of Highway Focus contains six papers depicting the application of geotechnical engineering in the design, construction, and maintenance of our highways. Although the problems presented in this issue are not new to highway engineers, the solutions implemented are quite innovative. Wire Mesh Blankets for rockfall control, the use of Alidrains for subsurface drainage, and the use of sawdust in highway fills, are a few of the many new and economical ideas being used by several State highway agencies.

Also included in this issue is an article which is a reprint of the New York Department of Transportation's Static Pile Load Test Manual. Pile capacity testing is an old and familiar art to construction engineers. However, it is a practice which is often overlooked. When a pile testing program is implemented, often the piles are tested to a predetermined load value regardless of whether failure has been achieved. This condition increases the probability of an overdesigned pile foundation. Hence, the end product is a safe, but uneconomical structure. The safety of a structure should never be compromised, but perhaps revitalization of pile testing practices could achieve an acceptable economic level while maintaining our high standards of safety.

As always, we solicit highway oriented case history papers from geotechnical engineers and geologists for future editions. All contributions should be sent to:

Roger D. Goughnour, Chief
Geotechnical and Materials Branch
Construction and Maintenance Division
Federal Highway Administration
Washington, D.C. 20590

OUR COVER

The cover, once again, draws attention to the role of geotechnical engineering in highway construction.

The two diagonally placed sketches on the cover typify methods familiar to every geotechnical engineer. A sand drain installation for stabilizing a soft foundation is shown with a superimposed potential failure surface that would require analysis prior to construction of an installation of this type. The other sketch shows a typical Mohr's failure envelope for defining the shear strength parameters for either soil or rock having weakened seams.

The diagonally placed photographs portray two common highway situations familiar to the traveling public--a rock cut and benched soil cut.

The benched soil cut photograph shows a section of Interstate 5 as it passes through the Siskiyou Mountains in southern Oregon. The extensive benching was required to maintain adequate slope stability and protection from rockfall in this area of slip-prone materials. In addition, an extensive system of underdrains was required to be installed within and below the embankment to ensure long-term stability. The photograph was furnished by the Oregon State Highway Department.

The impressive presplit rock cut portrays a part of the Route 17 Expressway in Delaware County, New York. The 240-foot deep cut was made in Hawk Mountain to provide alignment for both the new expressway below and also for relocation of old Route 17 on the terrace above. The photograph is the courtesy of the New York State Department of Transportation.

This bulletin is one of a series prepared periodically for distribution to Federal Highway Administration offices, State highway departments, and any other interested parties. Material has been composed from narrative reports covering highway engineering and construction operations. The purpose of this bulletin is to tell a story about highway engineering and construction operation features not generally regarded as normal or routine.

The opinions expressed in, or conclusions that may be drawn from the material contained in these special reports, are not to be taken as Federal Highway Administration endorsement of the equipment, methods, or techniques used. Republication for further distribution by field offices is permitted, but to prevent a situation wherein Federal Highway Administration endorsement could be implied, such republications are not to have Federal Highway Administration identification thereon.

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INSTALLATION OF WIRE MESH BLANKET TO CONTROL ROCK FALLS

BY

RICHARD M. LANE
RESEARCH GEOLOGIST
AND
SUNEEL N. VANIKAR
SOILS ENGINEER
NEW HAMPSHIRE STATE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

INTRODUCTION

There are a number of remedial measures that can be used to stabilize rock-slopes or control rock fall. Many of these techniques have been developed and used extensively in Europe. Several factors should be considered in the selection of a method or methods to correct a rock-slope stability problem: condition of the slope, geological factors, space available, maintenance required, environmental impact, aesthetics and total cost. Each problem area is unique and should be treated separately. The solution should be kept as simple as possible and methods can be combined or altered to meet the requirements of a specific case.

In 1978, a federally funded project was undertaken which involved remedial work on an existing rock cut located in Manchester, New Hampshire. The through cut consists of Northbound ON and OFF Ramps of Route I-93 at the Wellington Road Interchange. The work included construction of protective measures along both sides of the Northbound OFF Ramp, to restrain, channel and prevent rock-fall from reaching the roadway. These protective measures had to satisfy certain requirements and were subject to several restrictions: nearly maintenance free, minimum of interference to snow plowing operations, year-round protection, easily repairable if damaged, no significant change in the appearance of the existing slope and aesthetically pleasing.

The existing ditch design conforms to a typical, narrow urban section with a safety berm located along the toe of the rock slope. Many of the falling rocks were hitting the safety berm and being redirected out into the roadway. The falling debris is not only a hazard to motorists, but also created a dangerous situation for maintenance personnel. The rock fragments ranged in size from 2" to 10" with an occasional block, 2' to 3' in diameter.

The work was accomplished under two separate projects. The first project, completed in the fall of 1978, consisted of a rigid barrier erected along the left edge of the Northbound OFF Ramp for a distance of 300 linear feet. The barrier consists of a double faced beam guardrail with an additional beam along the bottom inside edge. For additional protection, the existing ditch area was covered with a one foot thick layer of energy absorbing material (crushed rock) and the safety berm was removed (See Photo 1).

Installation of similar guardrail was ruled out for the right side of the ramp because of the interference it may cause to the snowplowing operations. Removal of the safety berm without the use of guardrail was not acceptable because of safety considerations. Flattening of the rock slopes would have been expensive and would have required closing of the ramp.

A wire mesh blanket, to act as a protective measure, was recommended and installed along the right side of the Northbound OFF Ramp. The mesh, covering the entire rock slope from crest to toe, was recommended for a distance of 925± feet. In this section, the rock slope averages 55± feet in height with a maximum cut face of 70± feet. This portion of the cut has been the site of numerous rockfalls in which a significant number of rocks have reached the roadway.

GEOLOGY AND CONDITION OF THE SLOPE

The bedrock in the cut area is composed predominantly of a Quartz-Feldspar-Biotite Gneiss, randomly intruded by pegmatite. The pegmatite intrusions vary in size from 50'± wide to small penetrations into cracks and crevices, one inch in thickness.

The gneiss is moderately foliated, exhibiting some waviness due to buckling and folding during metamorphism. The foliation planes dip steeply and generally strike in a northeasterly direction, allowing for easy infiltration of surface water into the planes of weakness.

The pegmatite is composed of quartz, feldspar and minor amounts of biotite. Due to a high content of potash feldspar, it is highly susceptible to chemical weathering.

The major structural discontinuities affecting the stability of the rock slope are the foliation planes and four primary joint sets.

Throughout the rock cut, both the pegmatite and gneiss exhibit a wide range in durability, resulting in differential weathering. Portions of the slope are very highly weathered, while other sections are intersected by well defined joints forming a cubical pattern.

Based on close inspection of the slope, there is evidence in some areas of extensive over-blasting. Highly shattered faces, isolated blocks, overhanging arches and open joints are present. Loosening along the discontinuities has reduced the intact strength of the rock, making many sections more prone to rock fall.

Differential weathering in portions of the slope, undermined more competent, but highly jointed rock, resulting in rock fall. The situation has been further aggrevated by the convex configuration of the rock slope along the Northbound OFF Ramp, resulting in increased tensile stresses in the rock.

Severe weathering and iron staining has taken place along some of the steeply dipping joint planes. The weathered zones measure several feet across with up to 8" to 10" of clay like infilling. The weathered rock can be easily crumbled and in some cases has broken down into soil size particles.

In conclusion, the rock fall problem can be attributed to a combination of factors: over-blasting during excavation, differential weathering, the joint pattern, infiltration of water into opened joints and steeply dipping foliation planes resulting in accelerated chemical weathering and ice jacking, and the convex configuration of the slope.

CONSTRUCTION AND MATERIALS DETAILS

To restrain and guide falling rock fragments into the ditch area, the entire rock slope, from crest to toe, was covered with a heavy wire mesh. Along the top of the slope, the mesh was fastened to a wire rope. The wire rope was slung between and attached to grouted rockbolts. For additional support, the mesh was secured to an underlying grid of horizontal and vertical wire ropes. In most cases, the mesh and wire ropes were freely draped over the face of the slope. (See Figure 1.) If the wire mesh should become torn, it can be easily repaired by lacing it back together. In areas of severe icing, the wire mesh system can be designed for increased loads.

The installation of the mesh was accomplished in six construction stages with several operations done simultaneously (See Photos 2 through 8).

1. Erection of a temporary, 6 foot high, chain-link fence, along the edge of the roadway to prevent falling rocks and debris from reaching the traveled-way, during construction operations.

2. Minor scaling and cleaning of the rock-slope to remove loose and unstable rock fragments.

3. Drilling and installing resin grouted rock bolts.

4. Installation of the supporting grid of horizontal and vertical wire ropes.

5. Draping of the mesh over the rock-slope, wiring the vertical seams together and securing the mesh to the wire ropes.

6. Removal of all fallen rock and debris from the ditch area and restoration of the work site to its original condition.

WIRE MESH - The wire mesh is made of 11 gauge galvanized wire with a triple twist hexagonal weave. The size of the mesh openings is four and one-half inches by three inches with all the perimeter edges selvedged.

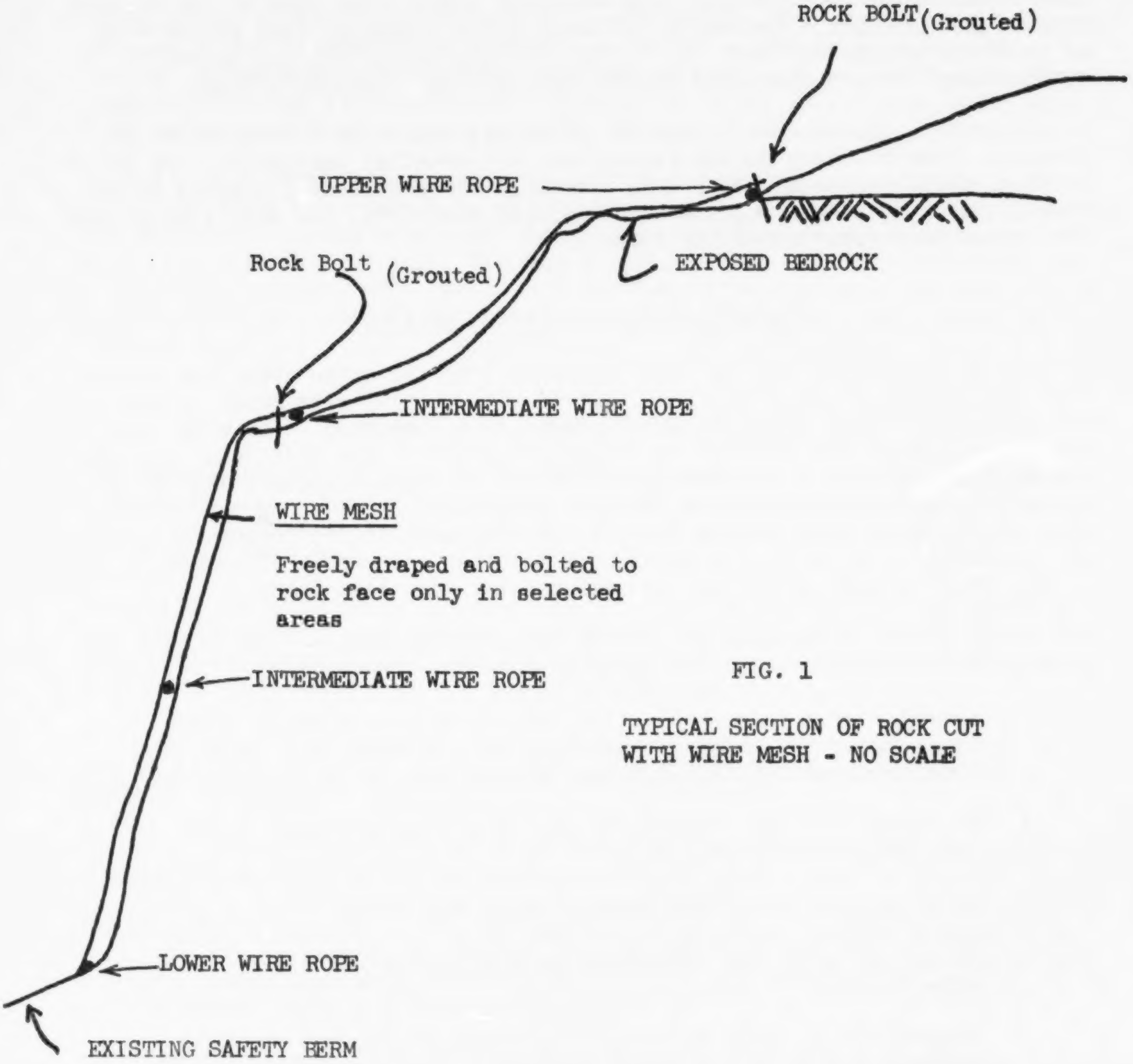
ROCK BOLT (Grouted)
UPPER WIRE ROPE
EXPOSED BEDROCK
Rock Bolt (Grouted)
INTERMEDIATE WIRE ROPE
WIRE MESH
Freely draped and bolted to rock face only in selected areas
INTERMEDIATE WIRE ROPE
LOWER WIRE ROPE
EXISTING SAFETY BERM

FIG. 1

TYPICAL SECTION OF ROCK CUT WITH WIRE MESH - NO SCALE

The wire mesh was installed in 15' wide vertical strips, each lapped over the other by a minimum of 12 inches. Adjacent vertical strips were connected with galvanized steel hog rings.

At the top and bottom, the mesh was folded underneath to form a minimum 12" lap. The horizontal laps were threaded by continuous weaving with 9 gauge, galvanized steel lacing wire. The mesh was then secured to the wire ropes by weaving of the lacing wire.

The wire mesh was delivered to the work site in large rolls, which measured 15 feet in width, 250 feet in length and weighed approximately 1350 pounds each. For handling and placing the rolls, the contractor constructed a large spool device. A small crane was used for lifting and moving the rolls. The fabric can be manufactured in narrower strips, but the larger size reduces the number of field joints to be made at the project site.

The bid item for the mesh consisted of furnishing and installing the wire mesh and accessories (lacing wire, hog rings, etc.) and minor scaling of the rock slope. The mesh was paid for at the contract unit price per square foot complete, in place.

WIRE ROPE - The wire rope is a 3/4 inch zinc-coated steel wire. A 6 X 19 strand wire rope with a "Fiber Core" was selected because of its flexibility and resilency. All wire rope accessories (U-bolts, wire rope clips, 4½" diameter rings and thimbles) were galvanized.

The wire rope and accessories were used to form a supporting grid of horizontal and vertical wires. The horizontal wire ropes consisted of an upper rope, a bottom rope and two intermediate ropes. Vertical wire ropes were hung at a maximum interval of 50± feet.

At 50 foot intervals along the upper edge of the mesh and at 150 foot intervals along the other horizontal ropes, 4½ inch diameter steel rings were used to join the intersecting vertical and horizontal ropes. The wire ropes were threaded through the rings, doubled over using a rope thimble and secured with wire rope clips. All remaining intersections were secured with U-bolts.

The bid item for wire rope consisted of installation and furnishing of accessories to include, U-bolts, wire rope clips, 4½ inch diameter steel rings, thimbles and all other incidentals. The wire rope was paid for at the unit contract price, per linear foot complete, in place.

ROCKS BOLTS - The rock bolts, used for anchoring the wire mesh and wire rope grid were high-strength, thread-deformed bars, 1" in diameter. Drilling was done with a hand-held air hammer. All the rock bolt holes extended a minimum of 5 feet into the bedrock. Before grouting with a polyester resin and harder, the boreholes were blown free of loose dust and water.

At 50 feet intervals along the upper edge of the mesh and at a 150 foot spacing above the break in slope, rock bolts were installed at the intersection of the vertical and horizontal wire ropes. At these locations, the steel rings were sandwiched between two steel bearing plates.

Additional rock bolts were installed above the break in slope with maximum spacing of 25 feet. At these locations, the mesh was placed between the rock face and a steel bearing plate.

Exposed portions of the rock bolts, bearing plates and head assemblies are protected with a coating of Bitumastic #50. This is a type of coal tar pitch used as a protective coating under severe corrosive conditions.

The rock bolt item consisted of furnishing, drilling, and installing rock bolts and accessories (bearing plates, nuts, etc.). The accepted quantity of rock bolts was paid for at the contract unit price per linear foot complete, in place.

DISCUSSION

The wire mesh protective system, the bid items, and cost to construct the wire mesh protective system were the following:

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
Rock Bolts for Wire Mesh	LF	450	15.80	7,110.00
Chain Link Fence with Vinyl-Coated Steel Fabric, 6' High	LF	300	15.00	4,500.00
Uniformed Officers and Flagmen		1	3,000.00	3,000.00
Maintenance of Traffic Including Dust Laying		1	10,400.00	10,400.00
Construction Signs and Warning Devices		1	9,200.00	9,200.00
Wire Mesh for Rock Slopes	SF	70,000	0.62	43,400.00
Wire Rope for Rock Slopes	LF	6,000	3.60	21,600.00
Mobilization		1	22,260.00	22,260.00
			GRAND TOTAL	121,470.00

To maintain a minimum of 12" lap between adjacent strips, in uneven areas of the rock slope, it was necessary in some places to overlap the mesh more than 12". This made it very difficult to estimate the quantity of wire mesh needed.

There was a problem in weaving the 9-gauge lacing wire. The wire is very rigid and difficult to bend by hand. To facilitate installation, the contractor was allowed to work with shorter lengths, 6 to 10 feet.

Drilling of the rock bolt holes was easier than anticipated, due to the weathered condition of the rock.

CONCLUSIONS

This was the first of this type of installation in the New England area. Wire mesh has been used successfully on similar projects in New Jersey, New Mexico, Washington, and Canada.

Although the wire mesh has not been in place at this location for a sufficient length of time to evaluate its performance, it has performed very well over extended periods of time, under severe conditions, in other parts of the country and Canada.

The wire mesh is quite strong and amazingly flexible. It blends into the slope and has a minimal impact on the environment. The mesh can be used very effectively as a remedial rock fall measure where space is limited for flattening the slopes and other measures can not be used. None of the work performed required any special equipment or expertise by the contractor. All phases of the installation do require a great deal of hand labor.

Wire mesh as a protective measure has its place in remedial rock-slope engineering. It is expected that in the future this type of installation may become more widely utilized in North America.

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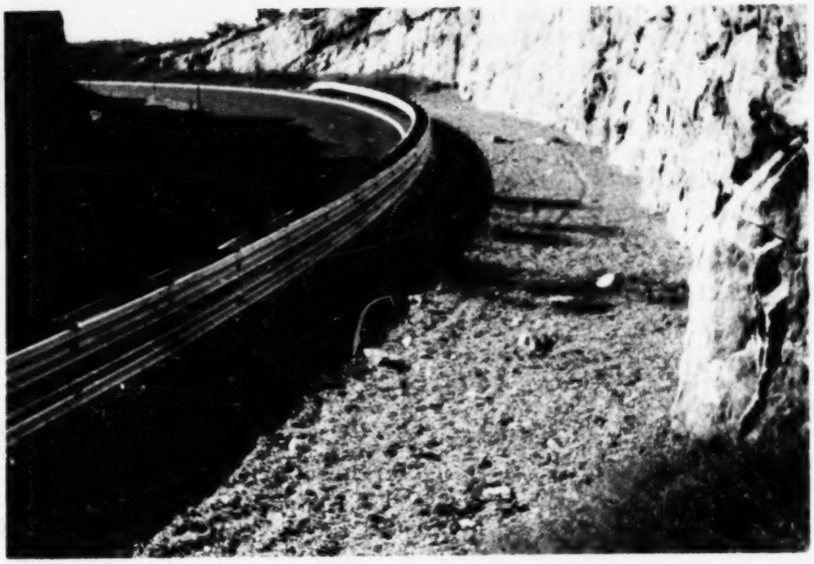


PHOTO 1. Double faced beam guard rail with an additional beam along the bottom inside edge. The ditch area is covered with a one foot thick layer of energy absorbing material (crushed rock).

PHOTO 2. Installation of wire mesh blanket.

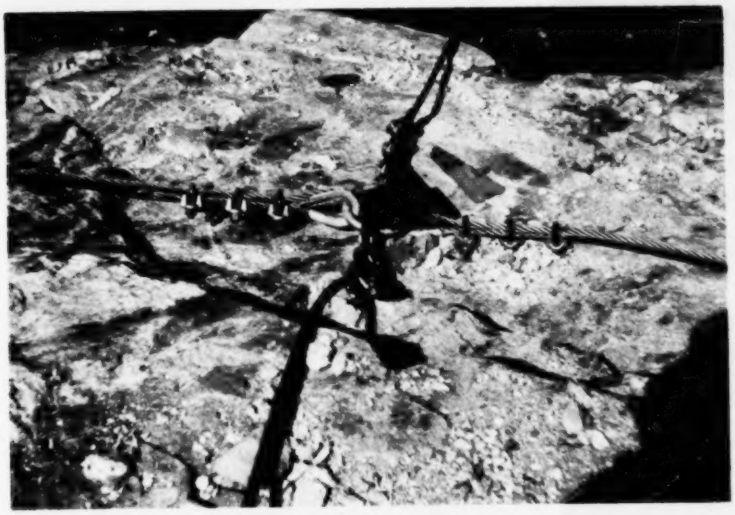
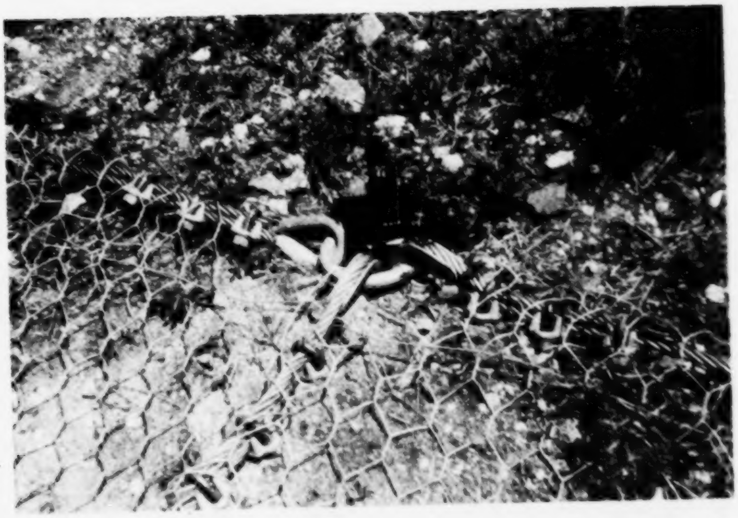


PHOTO 3. Installation of horizontal and vertical wire ropes with a 4½" diameter steel ring sandwiched between two steel plates.

PHOTO 4. Wire mesh fastened to underlying grid of wire ropes.



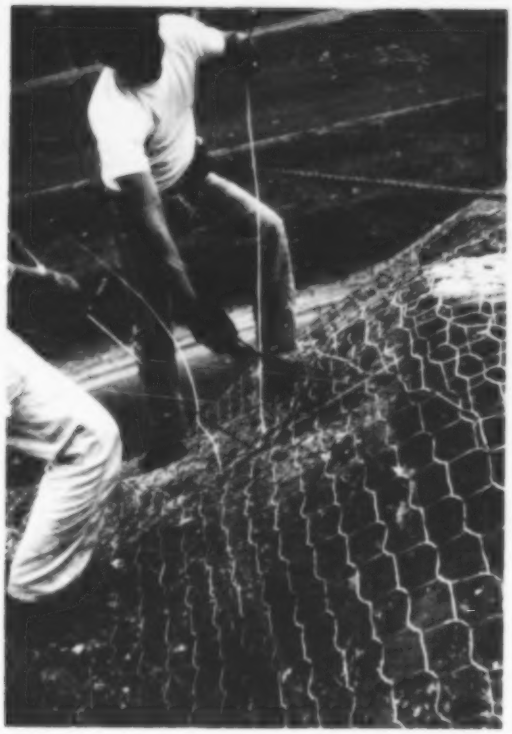


PHOTO 5. Fastening of mesh to wire ropes by continuous weaving of lacing wire.

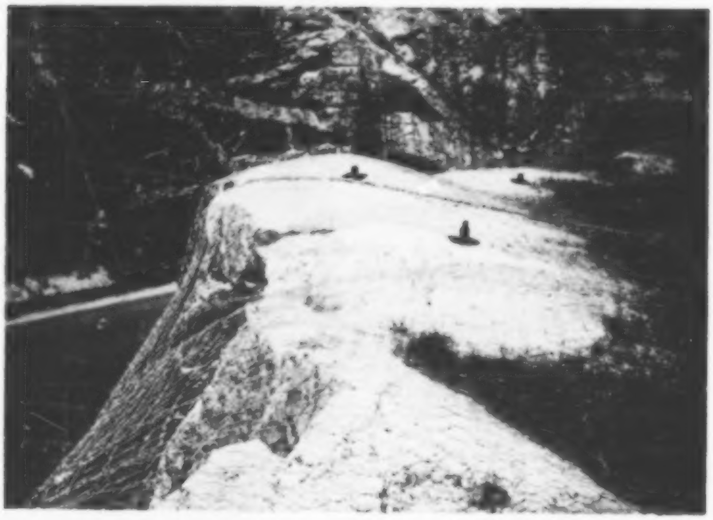


PHOTO 6. Above the crest of the rockslope the mesh is secured to the rock with rock bolts. The mesh is placed between the rock surface and a steel plate.

PHOTO 7. The wire mesh is freely draped over the rockface.

PHOTO 8. The wire mesh covers the entire rockslope from crest to toe.

EXPERIMENTAL EVALUATION OF VERTICAL PLASTIC DRAINAGE WICKS "ALIDRAINS" IN ILLINOIS

BY

Mr. Walter George
Environmental Trainee
FHWA Illinois

Introduction:

Vertical sand drains have been used in the United States since the early 1930's. They consist of sand columns installed by either mandrel, auger, or jetted method, using various spacing. The past performance record of sand drains has been mixed, ranging from poor to excellent in attaining the desired consolidation in the shortest possible time. The most important design factors for attaining successful sand drain performance are the diameter and spacing of the drain wells.

In the early 1940's, Mr. Walter Kjellman, head of the Swedish Geotechnical Institute, invented the Kjellman Cardboard Wick, the first premanufactured band-shaped drain. Because of poor filter permeability and low water transport capacity, a replacement for the Kjellman Wick was sought. In 1972, Mr. Oleg Wager, also of the Swedish Geotechnical Institute, patented the "Geodrain." The Geodrain consists of a plastic core containing 27 longitudinal water transport grooves wrapped in a paper filter.

The Geodrain had disadvantages similar to the Kjellman Wick, therefore, in 1975, Mr. Wager introduced a new drain strip - the "Alidrain." The Alidrain consists of a folded plastic strip which has studs of two heights on both outersides (Figure 1A). It is wrapped in a cellulosic filter. The studs provide space through which the water can freely flow and holes in the plastic strip provide water communication between the two sides.

Publications concerning Alidrains have emphasized its claimed superiority over sand drains in the Alidrains ability to provide rapid installation, negligible soil disturbance during installation, assured drain continuity, and equal or superior drainage performance.

Although the Alidrain has been widely used in Europe and Canada, it has been used on only one occasion for highway purposes in the United States (in Hawaii). Construction of Interstate Route 270 in the vicinity of East St. Louis, Illinois provided the opportunity to develop an experimental project to evaluate the field performance of Alidrains against conventional sand drains. The following report describes the physical conditions in the project area, a discussion of the soil characteristics in the location of the experimental area, the proposed and final solution for dealing with the anticipated settlement problem, a discussion of the experimental design, and a description of the installation of all experimental features.

Description of Location:

Interstate Route 270 provides two 36-foot pavements separated by a depressed median. The pavement is constructed of continuously reinforced Portland cement concrete on a 4-inch stabilized subbase, with stabilized shoulders provided on both the inside and outside. This is somewhat an unusual project in that the entire mainline will be constructed on embankment. There are no cut sections within the 26 mile length.

Physiographically, the proposed improvement is at the extreme northerly edge of the Salem Plateau Section of the Ozark Plateau Province. Geographically, the project is located in the broad floodplain of the Mississippi River, bordered on the west by the river, and on the east by the loessial bluffs. This alluviated valley is locally known as the American Bottoms. The topography within the project limits is level. Depressional drainage paths cross the area and a natural lake formed by the meandering of the river is located nearby at Frank Holten State Park. The mainline crosses Harding Ditch, a man-made structure built to control flooding caused by high precipitation.

The slope of the floodplain is very slight, resulting in generally poor drainage, which is compounded by runoff from the upland regions. Groundwater is encountered relatively close to the surface along the entire project route. The occurrence of thick deposits of clean granular material throughout the valley provides excellent aquifers for movement of groundwater through the valley in both the recharge and withdrawal cycles.

Soils Investigation:

A soils investigation was conducted by the Illinois Department of Transportation in 1971 with an addendum added in 1977. Split spoon and Shelby tube borings were made along the project to delineate suspected troublesome areas. Testing and soil boring analysis was performed by the Illinois Department of Transportation.

Subsurface conditions encountered in the project area are typical of those associated with major floodplains. The profile consists generally of a silty clay or clay from 5 to 35 feet in thickness, with interbedded silt and sand layers. The clay is underlain by deep sand which is graded from fine and very fine, to coarse at greater depths. Deep seated layers of alluvial clay were encountered in two areas. Both locations exhibited moisture contents of 50 percent and unconfined compressive strengths of less than one-half ton per square foot.

Moisture content of surficial soils ranges from the teens and twenties to the sixties.

Harding Ditch Location:

One of the locations containing deposits of the saturated alluvial clay was in the vicinity of the Harding Ditch crossing south of the U.S. Route 50. The soil conditions encountered at this site were further complicated by a 15-foot thick surface layer of clay that was preloaded.

Settlements south of the Harding Ditch crossing were calculated to be 10 to 11 inches, with 90 percent of the consolidation occurring in approximately 20 months. Settlements north of the Harding Ditch crossing were calcualted to be 7 to 10 inches, with 90 percent consolidation ranging from 8 to almost 100 months.

The saturated clay strata was buried 22 to 38 feet below the surface. Removal and replacement of this clay material was impractical because of its depth and because 5 to 15 feet of satisfactory material would have to have been removed before the saturated clay strata could be reached.

Surcharging the area was not considered to be a satisfactory solution. It was estimated that a 50 percent increase in embankment height would only shorten the 90 percent consolidation time by 15 to 25 percent. Surcharging would also have increased slope stability problems anticipated south of the Harding Ditch crossing. Therefore, in order to accelerate the anticipated settlement, it was recommended that sand drains be installed as the most feasible and economic solution.

Experimental Feature:

Coordination between the Illinois Department of Transportation and the Federal Highway Administration resulted in an agreement to incorporate, at the Harding Ditch crossing, an experimental section consisting of Alidrains and a control section of 12 inches jetted sand drains. The objective of this experimental feature was to evaluate the ability of the Alidrains, to accelerate the anticipated settlement, and to compare their performance with that of the sand drain control sections.

The experimental array consisted of three sections of Alidrains spaced at 4, 6, and 8 feet, center to center, in a triangular pattern. Two sections of standard 12-inch jetted sand drains arranged in a similar manner, spaced 10 feet center to center, were used as the control section. Each panel was designed to achieve 90 percent consolidation within 10 months. See Figure 1 for panel layout.

Installation of Sand Drains and Alidrains:

A 24-inch sand drainage blanket was constructed over the existing surface material to form a horizontal drainage layer between the proposed embankment and the natural ground. The sand was placed by end dumping and was not compacted.

Sand drains were installed by the jetted method utilizing a jet bailer suspended from a crane (Figure 2). The rate of advancement of the jetting pipe through the granular fill material and the underlying clay soils was predetermined based on measurements taken during trial drain installations. The rate of advancement was controlled to insure that all soils penetrated were removed by the jetting and washing action and to minimize the displacement and remolding of the soils adjacent to the sand drain (Figure 3). Upon reaching the required depth, the hole was washed until the fines suspended in the wash water did not exceed 7 percent. The percentage of fines was determined by hydrometer. On removal of the jetting pipe, a 12-inch diameter steel cage, suspended from a measured chain, was dropped into the hole to determine the "pay" depth, and to insure that the hole was open (Figure 4). Sand was delivered to the hole via a hopper with a 12-inch diameter sleeve (Figure 5). The hopper was filled by a front-end loader from a supply pile. Two settlement ponds were provided for the wash water and after settlement of the suspended material, the wash water was reused in the jetting operation. Personnel required to install the sand drains included one foreman, two operators, and four laborers. Installation required 7 to 10 minutes per drain.

Alidrains were installed using a chain driven device called a "stitcher" mounted to a front-end loader (Figure 6). The Alidrain material was inserted through a rhombic shaped mandrel used to protect it from tears, cuts, and abrasions during its installation. The protruding section of Alidrain was folded back around a piece of steel bar and tucked back into the mandrel (Figure 7). The steel bar prevents the Alidrain from slipping out of the mandrel during installation and holds the Alidrain in the ground while the mandrel is removed. The mandrel, Alidrain, and bar were then pushed into the ground by the stitcher (Figure 8). The Alidrains were pushed through the compressible layer of material to the natural sand layer. The mandrel was then withdrawn and the Alidrain was cut off 12-inches above the surface (Figure 9). Measurement of the "pay" length was determined by a depth measuring device attached to the chain of the stitcher's drive mechanism (Figure 10). The gauge was calibrated each day against measured lengths on the mandrel. Alidrain material was delivered in 150 meter rolls (Figure 11). New rolls were spliced onto the old rolls and fastened with staples (Figure 12). Personnel required to install Alidrains, included one foreman, one operator, and two laborers. Installation required approximately 2 minutes per drain.

Measurement of Settlement:

Piezometric measurement of excess pore pressure was used to determine the rate of embankment placement. Two observation wells were installed to monitor the natural ground water table. Automatic monitoring devices and settlement platforms were employed to measure the settlement rates. A diagram of the instrumentation set-up and drawings of measurement components can be found in Figures 13 through 18.

Costs:

On a cost per lineal foot basis, Alidrains have been estimated to cost substantially less than standard 12-inch jetted sand drains. Three of the four bids received on this contract supported this claim. This information is shown in Table 1, which lists the bid prices for the Alidrains and 12-inch jetted sand drains, the total bid price, and the percent the total bid was over or under the engineer's estimate.

TABLE 1

Contractor	A	B	C	D	Estimate
Unit Price Alidrain	$4.50	1.00	1.00	2.50	0.75
Unit Price Sand Drain	$4.70	3.50	5.00	5.00	6.00
Total Contract Amount	$2,081,533	2,333,333	2,333,850	2,731,280	2,492,413
% of Engineer's Est.	-16.5	-6.4	-6.4	+9.6	----

The only bidder who did not show a substantial price difference between the two methods was the overall low bidder on the contract. Based on the data in Table 1, as well as other information received, it appears the low bidder included other considerations in his price for the Alidrains. Therfore, cost comparisons based on the bids received on this contract would probably not be realistic. It should also be noted that a true comparison of costs would have to take into account any difference in spacing required for the two methods. Such a comparison obviously cannot be made until the required spacing is established based on performance evaluations.

Observations:

The photographs in this article were taken during a field trip to examine the actual installation procedures for Alidrains and jetted sand drains. The following comments are a result of observations made during this field trip.

Installation of the jetted sand drains involved 7 people and two pieces of large equipment, the coordination of which, at times, caused interruptions in the installation operation. The settlement ponds were located a substantial distance from the installation site, causing a communication difficulty between the jetting operations and those personnel operating the pumps. The sand supply pile was also some distance from the installation site, requiring long trips by the loader. Movement of the crane to new drilling sites resulted in delays due to its cumbersome maneuverability and adjustments of the water supply hoses. Weight and size of the crane and sand loader caused disturbance of the horizontal sand drainage blanket. Finally, wash water and waste material from the jetting procedure gave the operation a messy appearance and had the potential for obscuring or covering adjacent location stakes. Figure 19 represents a visual example of most of the above observations.

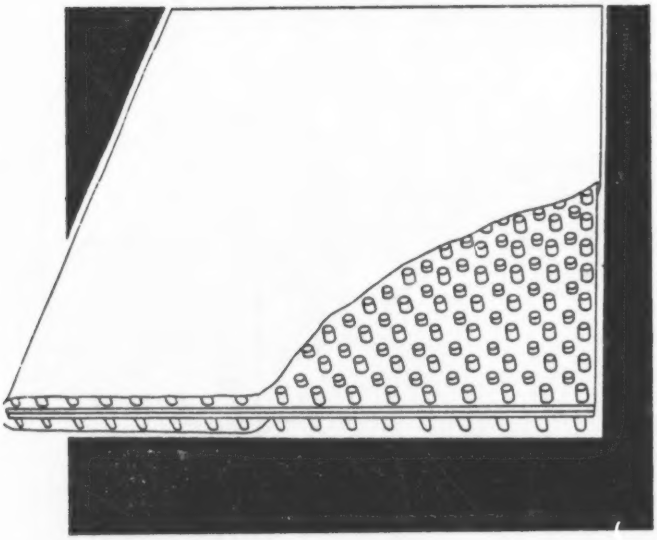
Installation of Alidrains involved only three people and one piece of equipment. The extent of the operation was compact with only one off-site area required for stock-piling rolls of Alidrain material. Time lost in replacing expended rolls of Alidrain was reduced by providing an on-board carrying device (Figure 20) capable of holding 5 rolls of Alidrain. Thus, trips to the supply pile were greatly reduced. The lighter weight of the front-end loader and stitcher resulted in a minimal disturbance of the horizontal sand drainage blanket. The foreground of Figure 21 shows a completed panel of Alidrains.

Summary:

Installation of Alidrains utilizes fewer people and equipment, less time, and provides a cleaner operation than jetted sand drains. From an environmental standpoint, Alidrains provide a more acceptable procedure than jetted sand drains because this method does not have the effluent disposal problem created by waste water and material from the jetted operation.

Although a good comparison of costs is not available from this project, it does not appear premature to conclude that given equal costs and performance between Alidrains and jetted sand drains, Alidrains would be the preferred method based on their lessened impact on the environment. However, a final recommendation cannot be made until the desired consolidation has been achieved for this project. Performance of the

Alidrains compared to jetted sand drains to bring about the desired consolidation, therefore, becomes a critical factor. Following placement of embankment, the State of Illinois will record settlement rate vs. time for each panel. Since each panel was designed to achieve 90 percent consolidation within 10 months, the ability to attain the desired consolidation within a given time period, provides a suitable basis for judging the performance of Alidrains and jetted sand drains.



The Alidrain.

Figure 1A

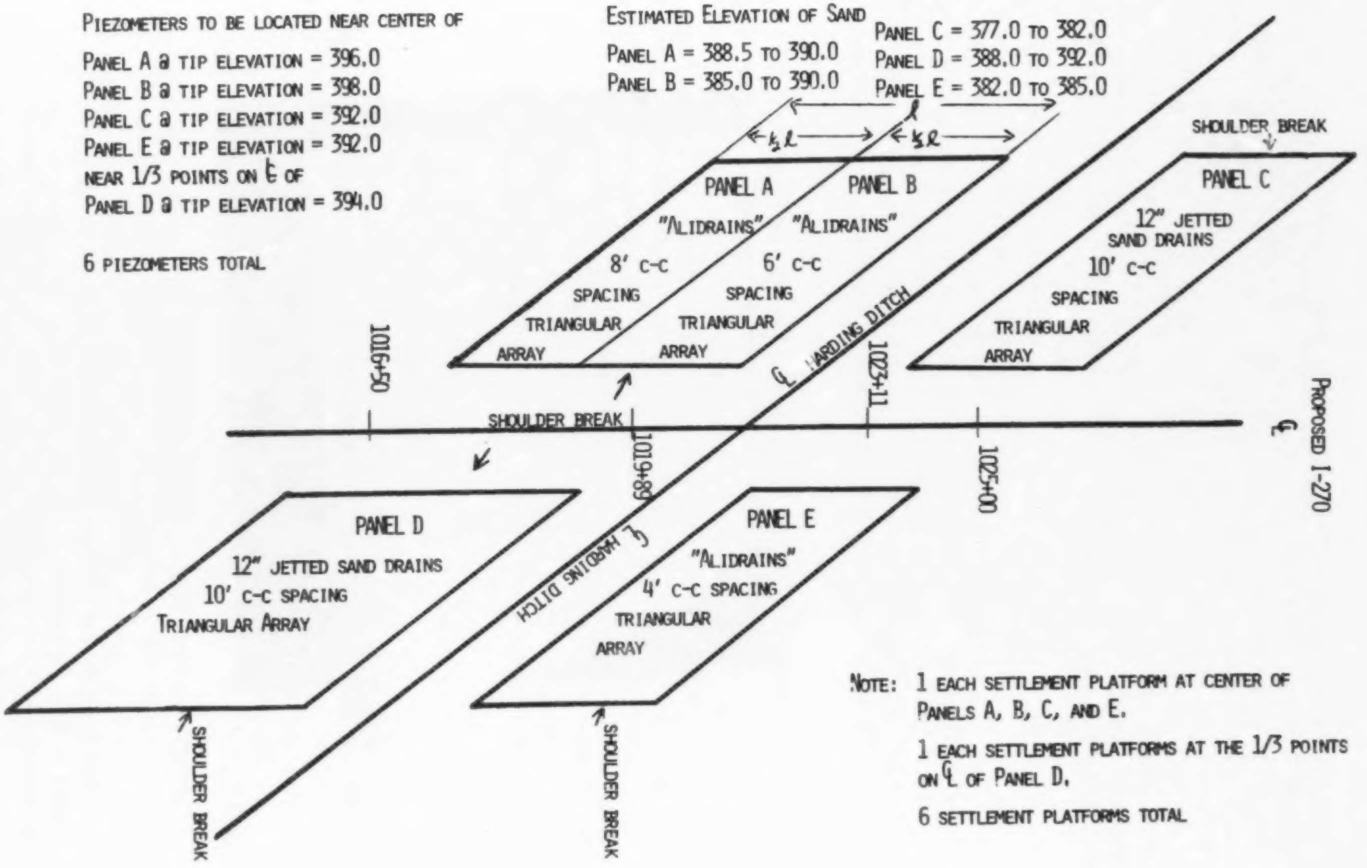
PIEZOMETERS TO BE LOCATED NEAR CENTER OF

PANEL A @ TIP ELEVATION = 396.0
PANEL B @ TIP ELEVATION = 398.0
PANEL C @ TIP ELEVATION = 392.0
PANEL E @ TIP ELEVATION = 392.0
NEAR 1/3 POINTS ON ℄ OF
PANEL D @ TIP ELEVATION = 394.0

6 PIEZOMETERS TOTAL

ESTIMATED ELEVATION OF SAND

PANEL A = 388.5 TO 390.0
PANEL B = 385.0 TO 390.0
PANEL C = 377.0 TO 382.0
PANEL D = 388.0 TO 392.0
PANEL E = 382.0 TO 385.0


l
½l
½l
PANEL A
"ALIDRAINS"
8' c-c
SPACING
TRIANGULAR
ARRAY
PANEL B
"ALIDRAINS"
6' c-c
SPACING
TRIANGULAR
ARRAY
SHOULDER BREAK
PANEL C
12" JETTED
SAND DRAINS
10' c-c
SPACING
TRIANGULAR
ARRAY
℄ HARDING DITCH
PROPOSED I-270
℄
1016+50
SHOULDER BREAK
1019+89
1023+11
1025+00
PANEL D
12" JETTED SAND DRAINS
10' c-c SPACING
TRIANGULAR ARRAY
℄ HARDING DITCH
PANEL E
"ALIDRAINS"
4' c-c SPACING
TRIANGULAR
ARRAY
SHOULDER BREAK
SHOULDER BREAK

NOTE: 1 EACH SETTLEMENT PLATFORM AT CENTER OF PANELS A, B, C, AND E.

1 EACH SETTLEMENT PLATFORMS AT THE 1/3 POINTS ON ℄ OF PANEL D.

6 SETTLEMENT PLATFORMS TOTAL

FIGURE 1

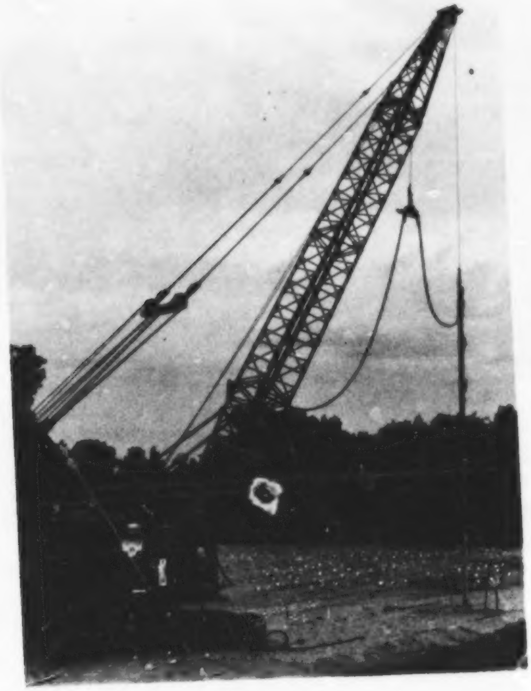


Figure 2

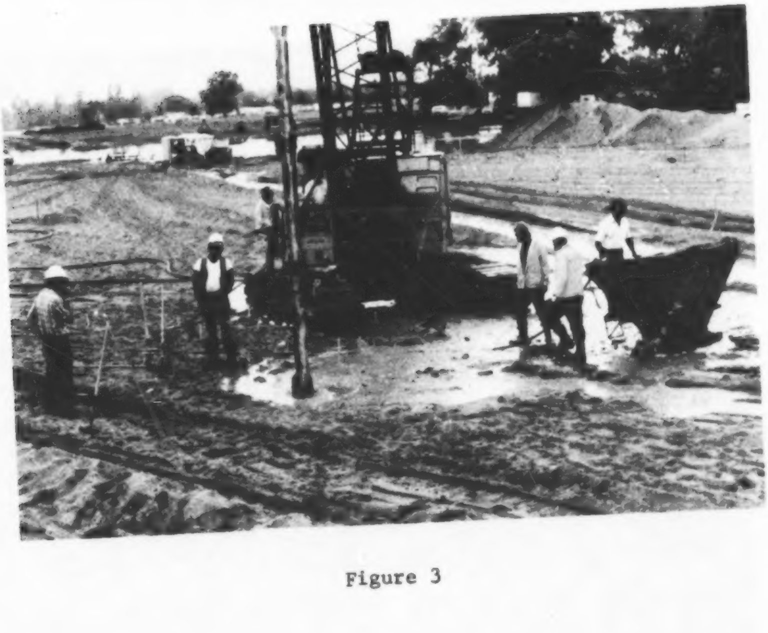


Figure 3

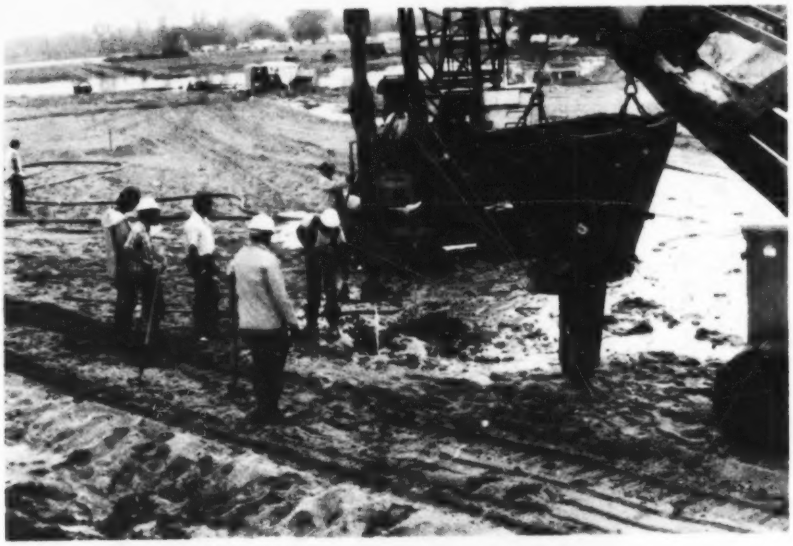


Figure 4

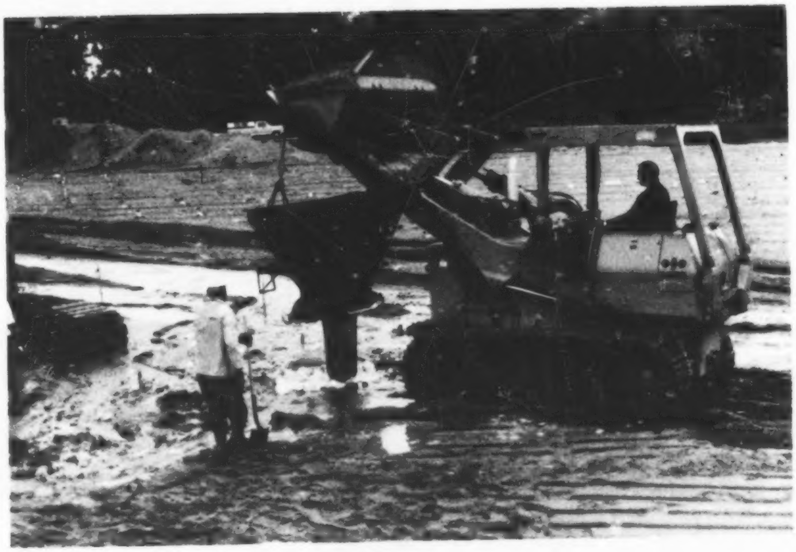


Figure 5

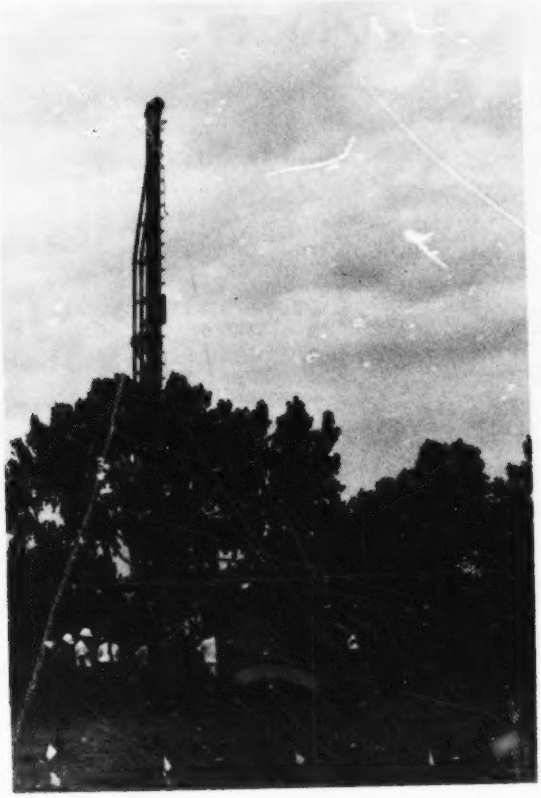


Figure 6

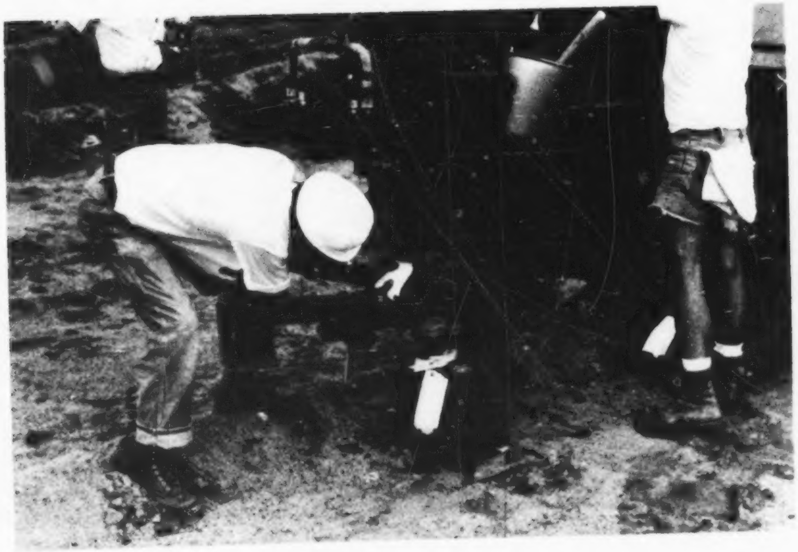


Figure 7

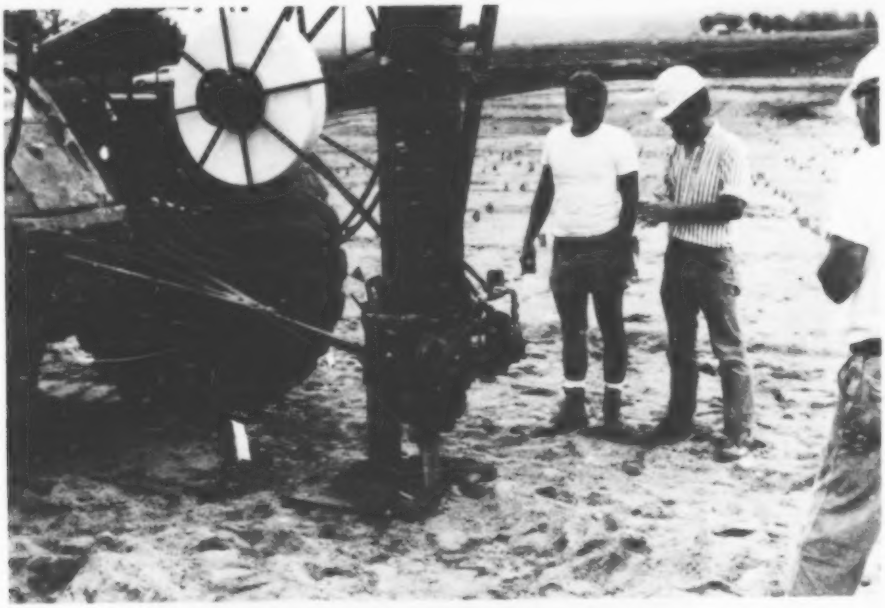


Figure 8

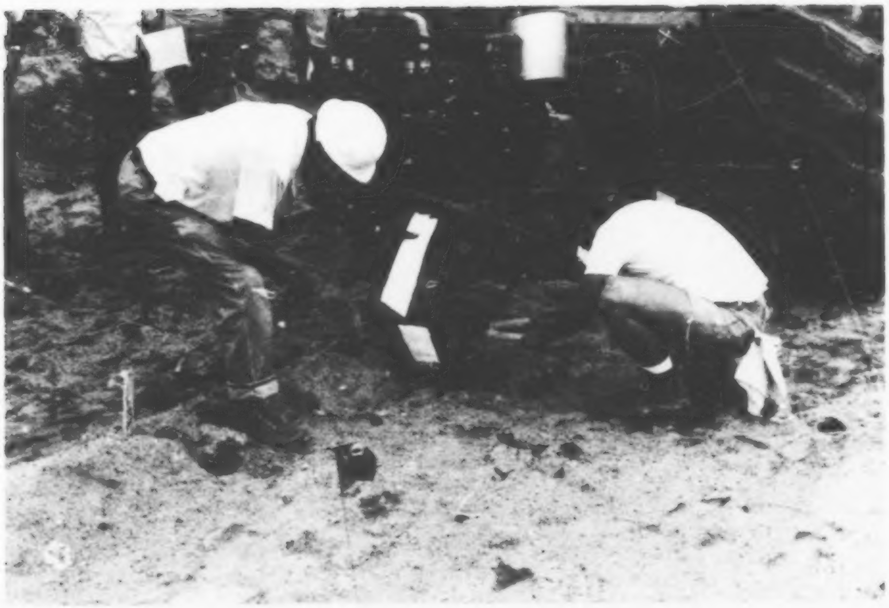


Figure 9

Figure 10

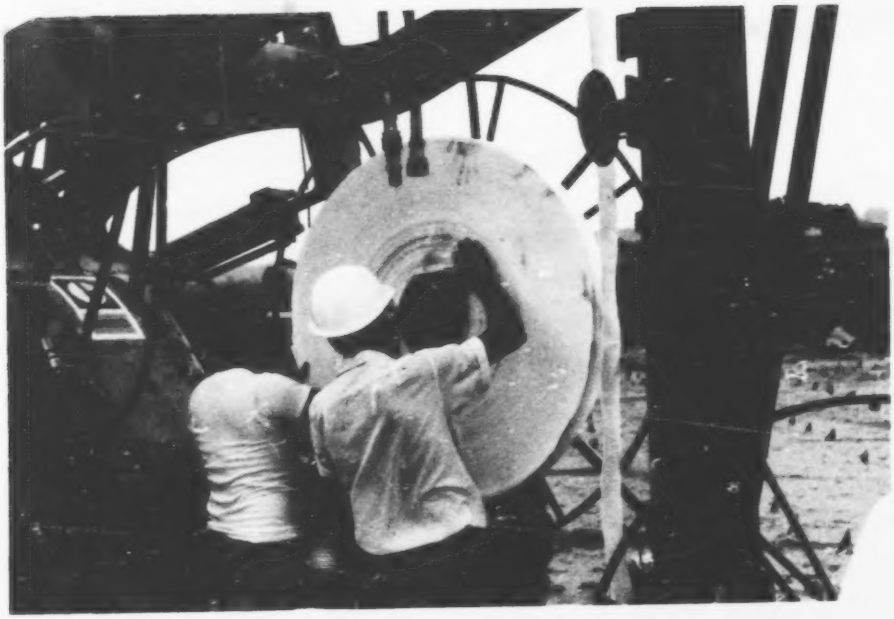


Figure 11

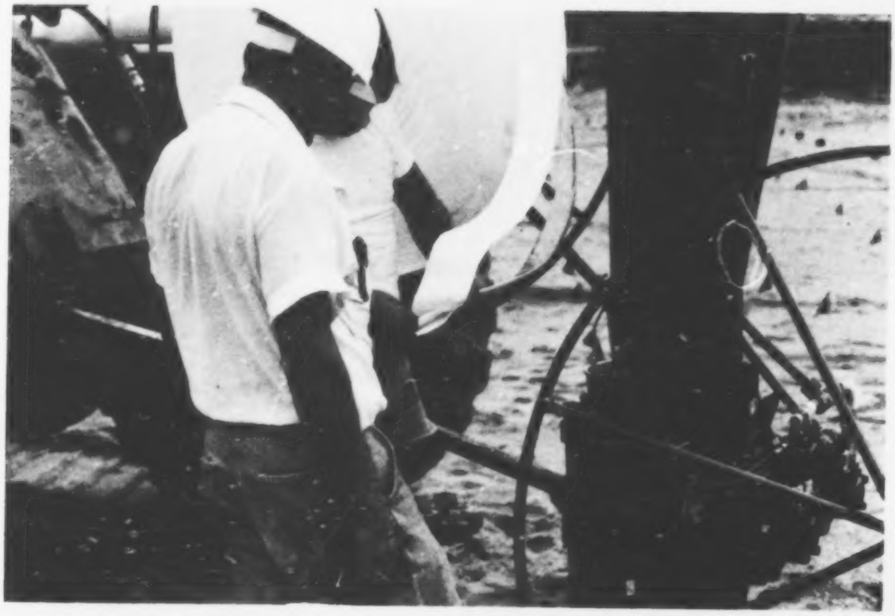
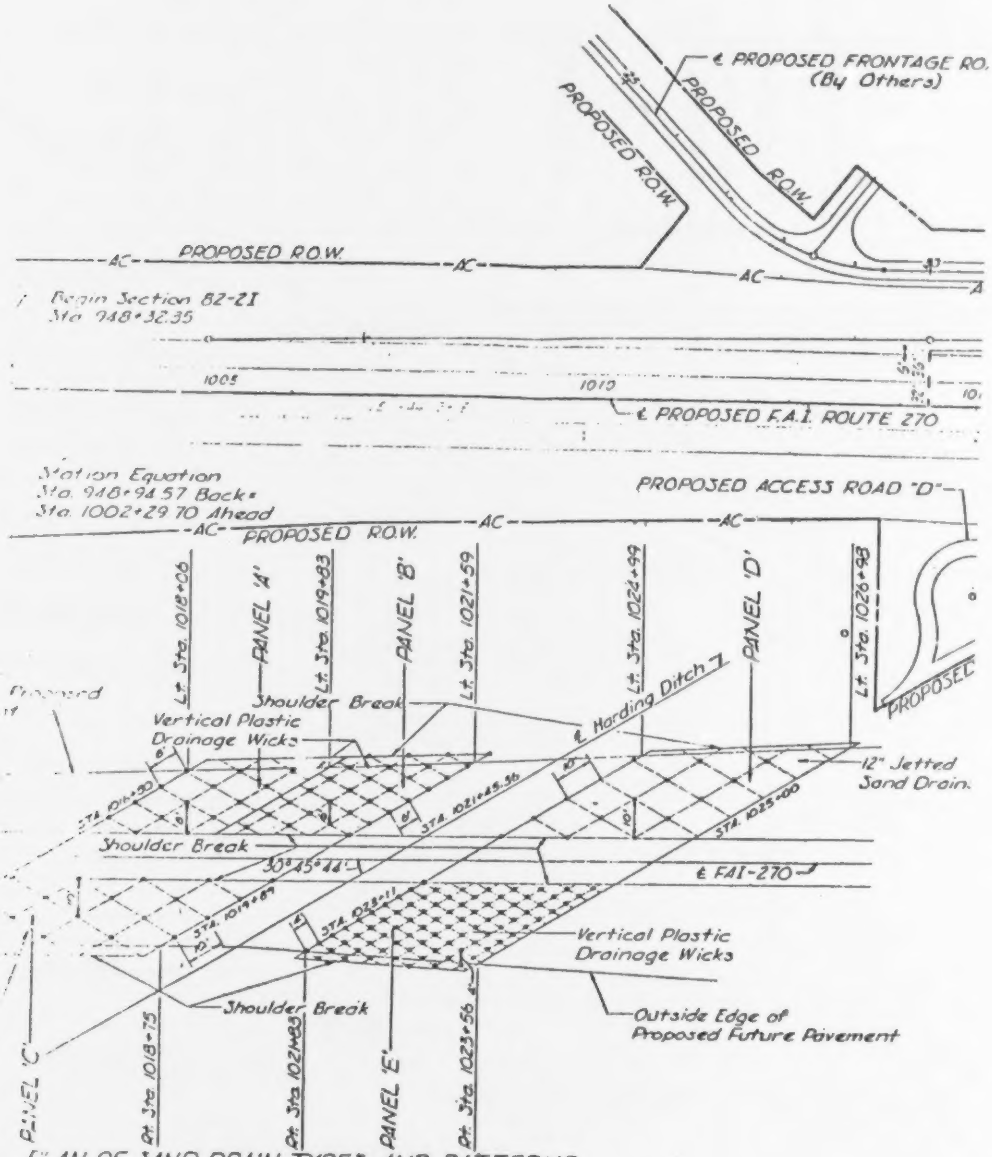
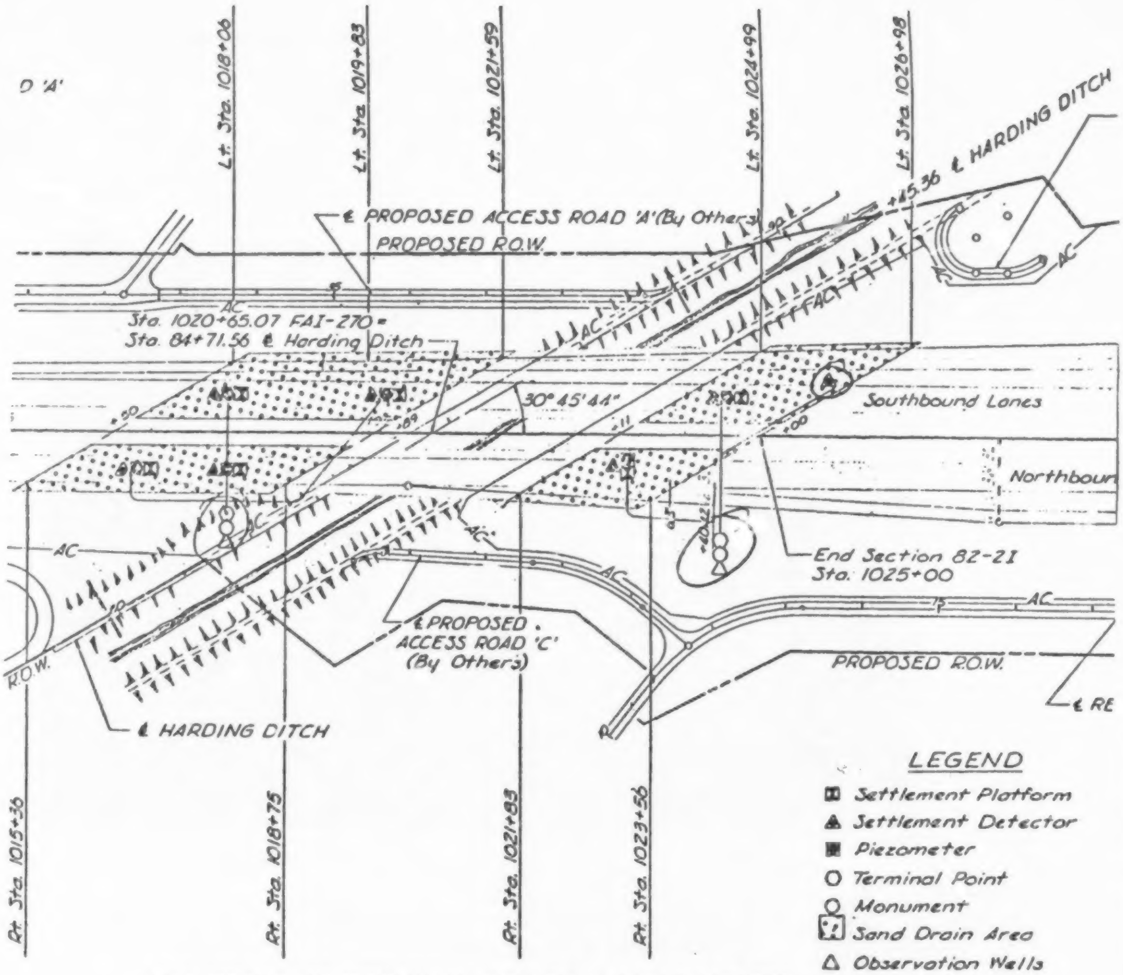


Figure 12


℄ PROPOSED FRONTAGE RD.
(By Others)
PROPOSED R.O.W.
PROPOSED R.O.W.
PROPOSED R.O.W.
AC
AC
AC
Begin Section 82-21
Sta. 948+32.35
1005
1010
℄ PROPOSED F.A.I. ROUTE 270
Station Equation
Sta. 948+94.57 Back=
Sta. 1002+29.70 Ahead
PROPOSED ACCESS ROAD "D"
PROPOSED R.O.W.
AC
AC
AC
Lt. Sta. 1018+06
PANEL 'A'
Lt. Sta. 1019+83
PANEL 'B'
Lt. Sta. 1021+59
Lt. Sta. 1024+99
PANEL 'D'
Lt. Sta. 1026+98
PROPOSED
Proposed
Shoulder Break
Vertical Plastic
Drainage Wicks
℄ Harding Ditch
12" Jetted
Sand Drain
STA. 1018+50
STA. 1021+45.36
STA. 1025+00
6'
6'
6'
10'
10'
Shoulder Break
30°45'44"
℄ FAI-270
STA. 1019+89
STA. 1023+11
10'
4'
Vertical Plastic
Drainage Wicks
Shoulder Break
Outside Edge of
Proposed Future Pavement
PANEL 'C'
Rt. Sta. 1018+75
Rt. Sta. 1021+83
PANEL 'E'
Rt. Sta. 1023+56

PLAN OF SAND DRAIN TYPES AND PATTERNS
No Scale

FIGURE 13


D 'A'
Lt. Sta. 1018+06
Lt. Sta. 1019+83
Lt. Sta. 1021+59
Lt. Sta. 1024+99
Lt. Sta. 1026+98
+45.36 ℄ HARDING DITCH
℄ PROPOSED ACCESS ROAD 'A' (By Others)
PROPOSED R.O.W.
AC
Sta. 1020+65.07 FAI-270 =
Sta. 84+71.56 ℄ Harding Ditch
30° 45' 44"
Southbound Lanes
Northbour
End Section 82-21
Sta. 1025+00
℄ PROPOSED
ACCESS ROAD 'C'
(By Others)
PROPOSED R.O.W.
R.O.W.
℄ RE
℄ HARDING DITCH
Rt. Sta. 1015+36
Rt. Sta. 1018+75
Rt. Sta. 1021+83
Rt. Sta. 1023+56
LEGEND
Settlement Platform
Settlement Detector
Piezometer
Terminal Point
Monument
Sand Drain Area
Observation Wells

LOCATION OF TERMINAL POINTS & MONUMENTS

Sta. 1018+00	115' Rt.	120' Rt.
Sta. 1024+50	145' Rt.	150' Rt.

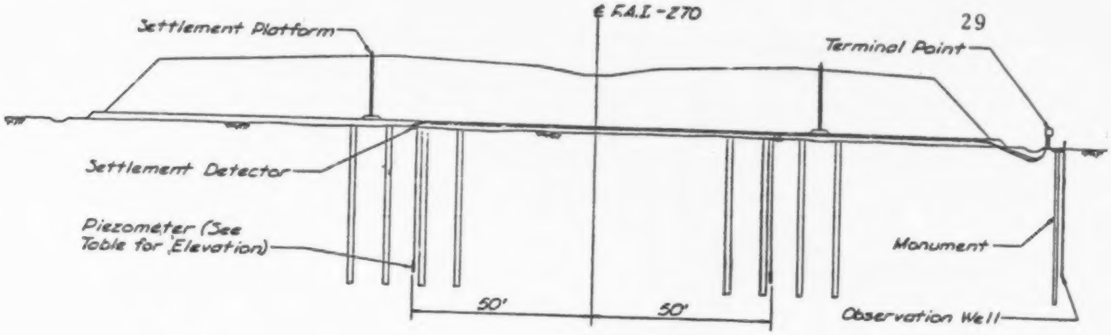
TOTAL = 2 TERMINAL POINTS
TOTAL = 2 MONUMENTS

LOCATION OF OBSERVATION WELLS

Sta. 1018+00	125 Rt.
Sta. 1024+50	155 Rt.

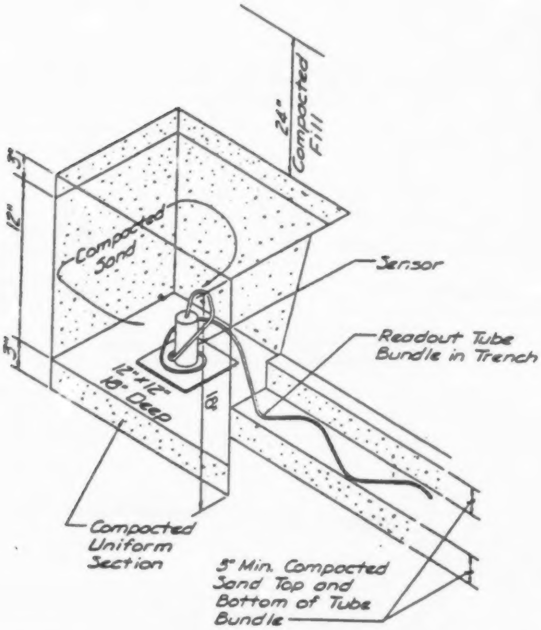
TOTAL = 2 OBSERVATION WELLS

FIGURE 13 (cont.)


℄ F.A.I.-270
Settlement Platform
Terminal Point
Settlement Detector
Piezometer (See Table for Elevation)
Monument
50'
50'
Observation Well

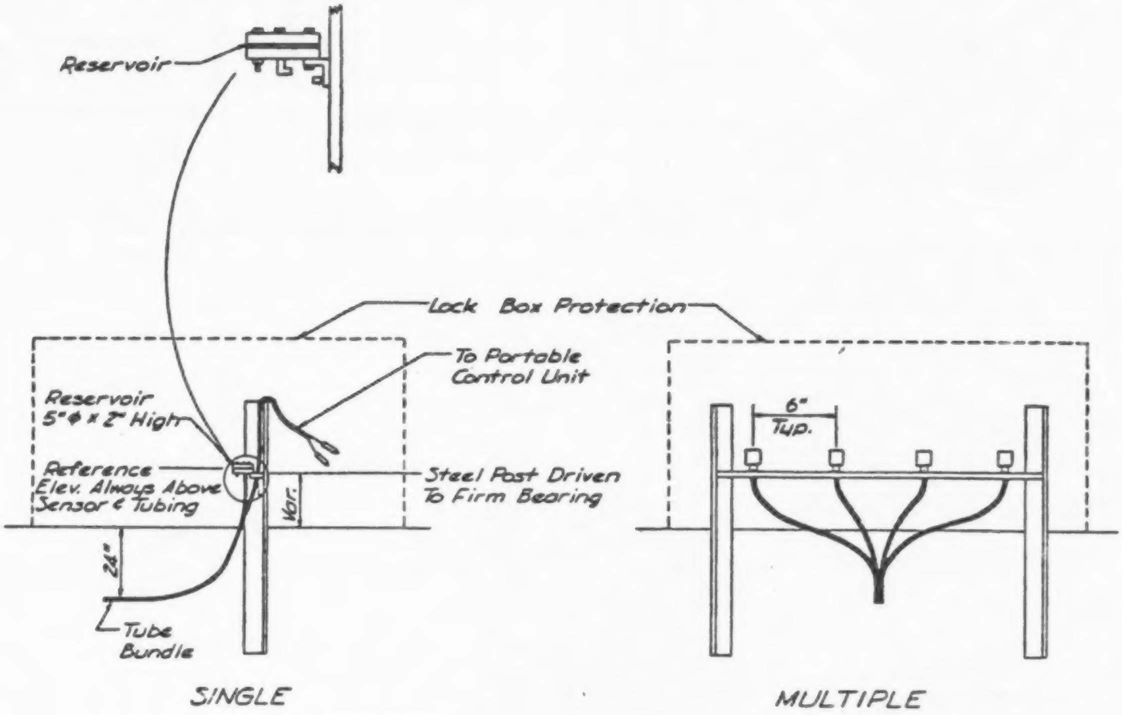
EMBANKMENT SETTLEMENT SYSTEM LAYOUT

Figure 14


24" Compacted Fill
3"
12"
3"
Compacted Sand
Sensor
Readout Tube Bundle in Trench
12"x21" 18" Deep
18"
Compacted Uniform Section
5" Min. Compacted Sand Top and Bottom of Tube Bundle

SETTLEMENT DETECTOR DETAIL

Figure 15


Reservoir
Lock Box Protection
To Portable Control Unit
Reservoir 5"ϕ x 2" High
Reference Elev. Always Above Sensor ¢ Tubing
Steel Post Driven To Firm Bearing
Var.
24"
Tube Bundle
6" Typ.
SINGLE
MULTIPLE

MOUNTING OF RESERVOIRS

Figure 16

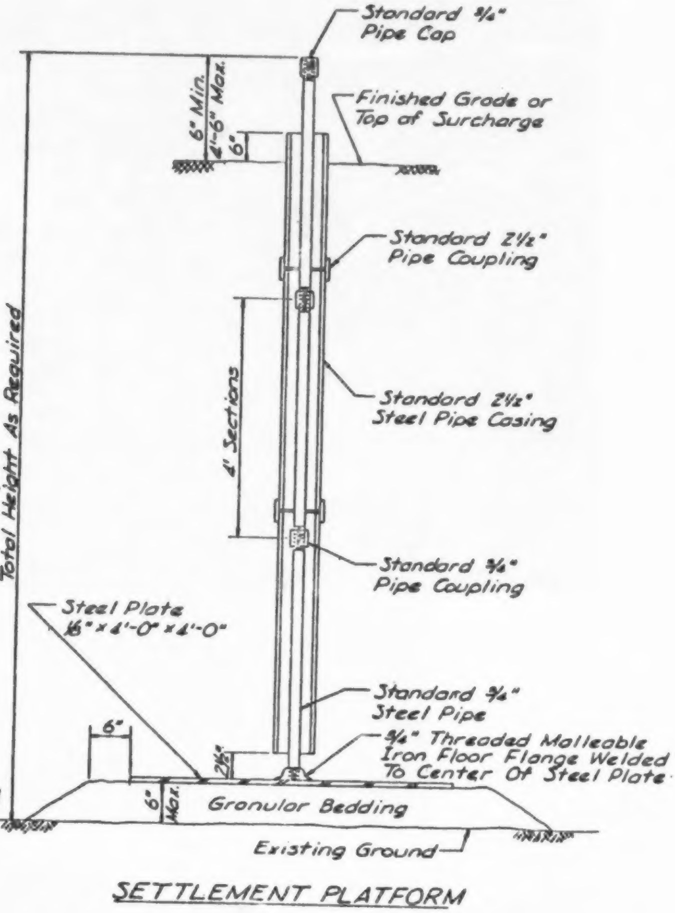

Standard ¾" Pipe Cap
Finished Grade or Top of Surcharge
6" Min.
4'-6" Max.
6"
Standard 2½" Pipe Coupling
4' Sections
Standard 2½" Steel Pipe Casing
Standard ¾" Pipe Coupling
Total Height As Required
Steel Plate ⅛" × 4'-0" × 4'-0"
Standard ¾" Steel Pipe
6"
2½"
¾" Threaded Malleable Iron Floor Flange Welded To Center Of Steel Plate
6" Max.
Granular Bedding
Existing Ground
SETTLEMENT PLATFORM

Figure 17

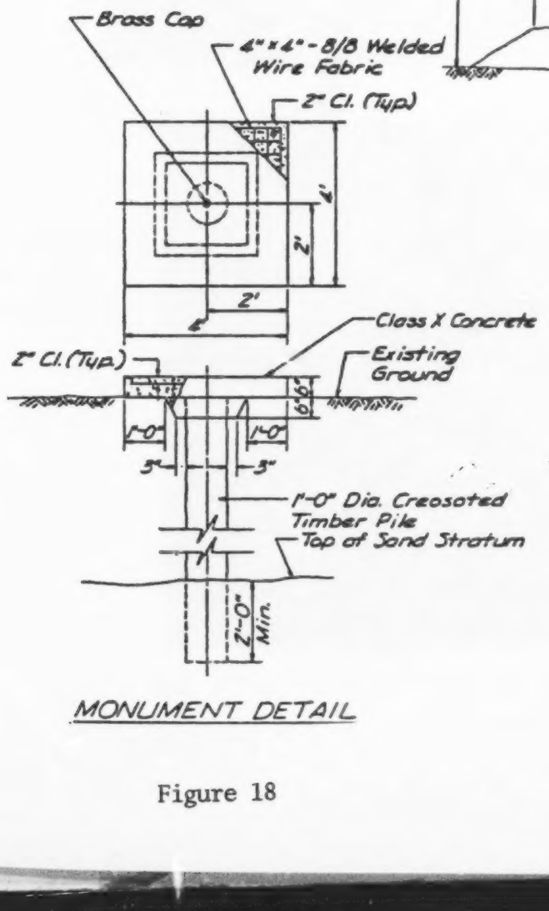

Brass Cap
4" × 4" - 8/8 Welded Wire Fabric
2" Cl. (Typ.)
4'
2'
2'
4'
Class X Concrete
2" Cl. (Typ.)
Existing Ground
6"
1'-0"
1'-0"
3"
3"
1'-0" Dia. Creosoted Timber Pile
Top of Sand Stratum
2'-0" Min.
MONUMENT DETAIL

Figure 18

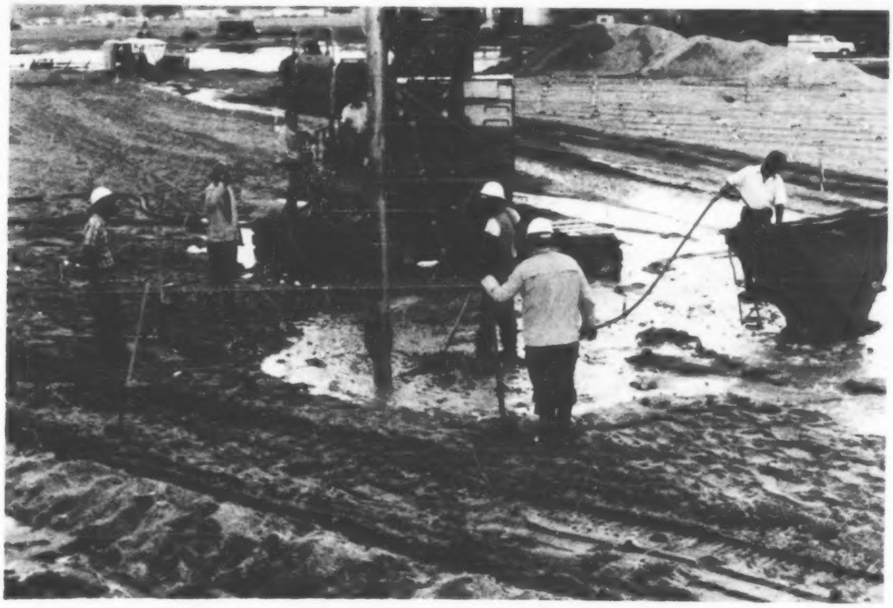


Figure 19

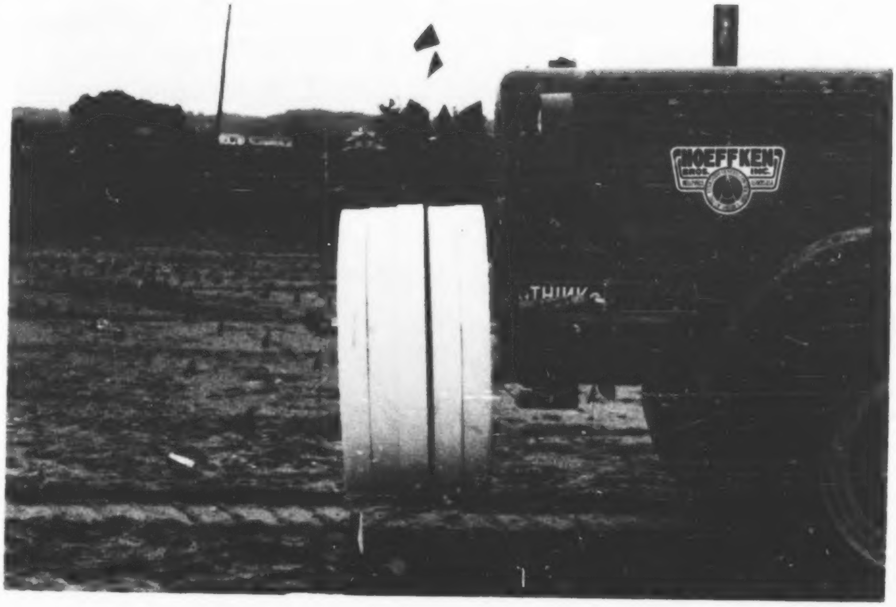

HOEFFKEN
THINK

Figure 20

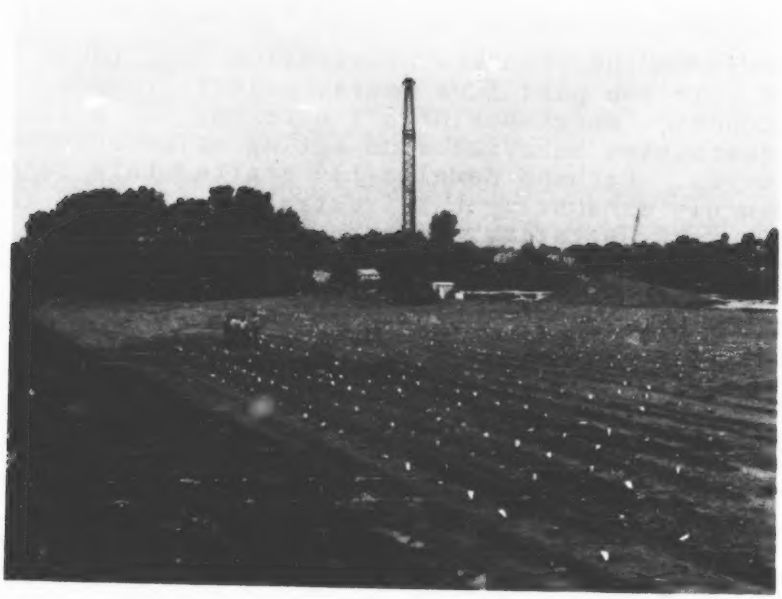


FIGURE 21

USE THE SPT TO MEASURE DYNAMIC SOIL PROPERTIES?-YES, BUT....![1]

BY

J. H. Schmertmann[2]

Worldwide interest in the standard penetration test (SPT) has increased greatly in the past five years, primarily as a result of the great economic importance of SPT data for the evaluation of possible liquefaction behavior when siting major onshore and offshore structures. Perhaps deMello(1)[3] started this renewed interest through his exhaustive but frustrating state-of-the-art paper on the SPT. "Frustrating" because he found, despite an exhaustive search, virtually no carefully controlled research on the SPT. Since then the present author and others have performed controlled research involving both the statics and dynamics of the SPT, which has led to important new insight into what happens during the SPT.

The author believes that understanding the SPT first requires an understanding of its dynamics. It then becomes clear that the SPT blowcount measurement, or N-value, results from the dynamic interactions between hammer, rods, sampler, and soil. In principle, a dynamic test such as the SPT should model a dynamic structure-soil interaction problem or at least sense some dynamic behavior properties of the soil sampled.

The SPT models the pile-driving problem and there exists a good theoretical connection between SPT behavior and the damping coefficients, J_p and J_s, very important in any wave equation analysis of pile-driving problems. Seed (2) showed that SPT N-values also appear to correlate well, at least qualitatively, with liquefaction behavior. Also, as shown subsequently by an example, the SPT N-values may correlate well empirically with shear wave velocity, V_s. The dynamic SPT should, in principle, correlate better with dynamic soil behavior than with any static or quasi-static test such as the Dutch cone penetration test (CPT).

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3. The numbers in parentheses refer to the list of references appended to this paper.

Unfortunately, before any of these important dynamic soil property correlations can reach a quantitatively useful point of reliability and reproducibility, matching what we usually expect from our engineering tests, the profession must make important modifications to the present ASTM Penetration Test and Split-Barrel Sampling of Soils (ASTM D 1586) standard. This paper includes suggestions for such modifications.

A Minisurvey of New Research Knowledge

Schmertmann (3) showed in a discussion to deMello (1) that soil friction or adhesion along the inside and outside surfaces of the SPT sampler could account, and probably did account, for a major portion of the total static and dynamic soil resistance against sampler penetration. The percentage of side shear to total resistance usually increases as the cohesiveness of the soil increases. This means that a major portion of the energy of the sampling goes into shear. As a practical demonstration of this fact, Stokoe and Woods (4) found the SPT an acceptable way of introducing waves rich in shear energy in their crosshole shear wave velocity measurements.

Reasoning that the variables that affect the CPT would likely affect the SPT in a similar manner, Schmertmann (3) pointed out the probable major importance of the in situ horizontal effective stresses in determining the N-value in a soil. Zolkov and Weisman (5) had already suggested this possibility in their study of sand overconsolidated by the removal of overburden. Rodenhauser (6), working in a triaxial test chamber at Duke University, obtained SPT results in a dry sand, indicating N proportional to the octahedral stress to the 2/3 power. Marcuson and Bieganousky (7) (Fig. 10) report a marked increase in N at overconsolidation ratio (OCR) = 3 compared with the same sand at OCR = 1, presumably due to the greater lateral stresses after overconsolidation. From all of this it seems clear that in situ horizontal stresses play a major role, perhaps a dominant role, in determining N.

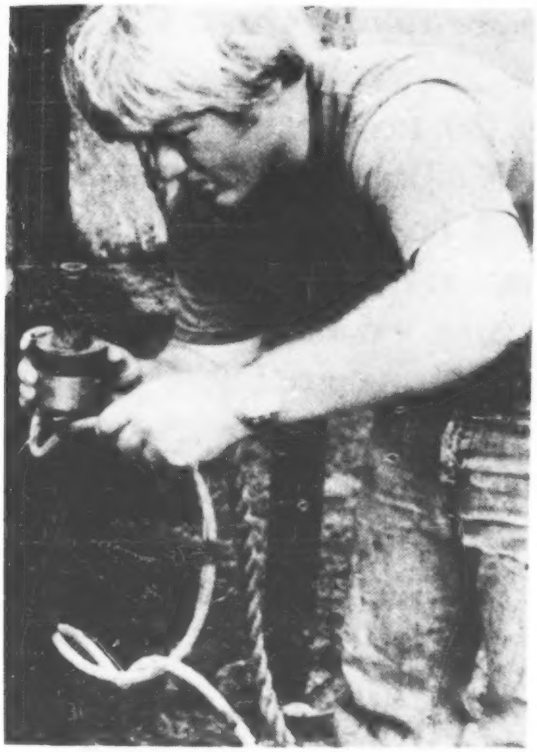
N-values have played an important role in the field evaluation of liquefaction potential. Seed and Idriss (8) used N-values to estimate relative density, then compared field liquefaction and no-liquefaction cases with relative density and earthquake acceleration, and then finally prepared N-value and depth charts to indicate the likelihood of liquefaction. The first step in this reasoning, estimating D_r from N, received severe criticism at the time (9-11). More recently, the controlled N-D_r study recently completed by the Waterways Experiment Station and reported by Marcuson and Bieganousky (7) tends to further discredit the quantitative use of any such correlation unless made specifically for a given site. Although the Seed and Idress double use of N-values reduces the importance of the N-D_r first step, Seed has responded to such criticism and to new research knowledge and has not eliminated this step entirely by suggesting the direct use of N-values without an intermediate correlation with relative density. With this new method, the factor of safety against liquefaction varies linearly with the N-value. Thus, a 100 percent error in N would result in a 100 percent error in factor of safety.

Only recently have researchers begun to delve into the question of understanding the dynamics of the SPT. Kovacs et al (12,13) have made direct measurements of the velocity of the 63.5-kg (140 lb) SPT hammer at the instant of impact with the anvil-rod system. Their research has demonstrated quantitatively what others, such as Frydman (4), Zolkov (11,15), and Serota and Lowther (16), showed only via the gross measurement of blow-count ratios--the large variations in N due to different hammer-drop systems. Their data showed definite trends from which they deduced that increasing the energy in the hammer at impact would decrease N, with some preliminary indications of N proportional to the inverse of hammer energy.

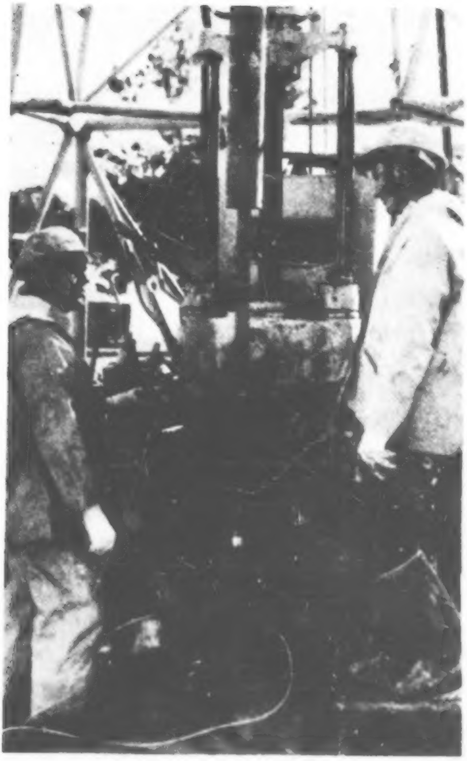
Schmertmann (17) reported on perhaps the first experimental investigation of the dynamic behavior involved when an SPT sampler penetrates the soil in response to the stress waves generated by the SPT hammer blow. The following section of this paper discusses in a summary way some of the findings from this research. The reader interested in details can consult the Ref 17. This research involved a coordinated study of dynamic force-time measurements obtained just below the hammer and just above the sampler, resistance measurements during the quasi-static penetration of an SPT sampler, associated quasi-static friction-cone penetration tests, and computer simulations using the one-dimensional wave equation. Figure 1 shows some photos from the research.

Review of Dynamics of SPT Sampler Penetration

From the coordinated research study at the University of Florida mentioned earlier, the author found that the following sequence of events takes place during a single SPT blow:

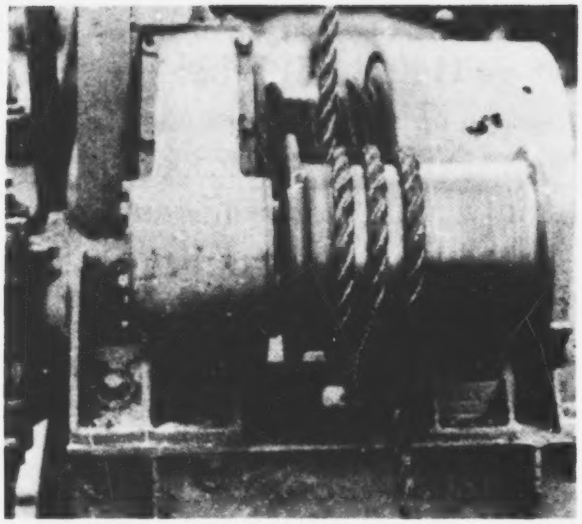


(a) Screwing the dynamic load cell into the string of rods.



(b) The SPT hammer-rod system with load cell in place.

Fig. 1 - Measuring the dynamic energy input into the SPT rods for research or calibration or both.



(c) Typical manila rope & cathead system used to raise and drop the SPT hammer (note 3 turns).

(d) Hammer strikes anvil & simultaneously hits trigger to begin force-time record from load cell.

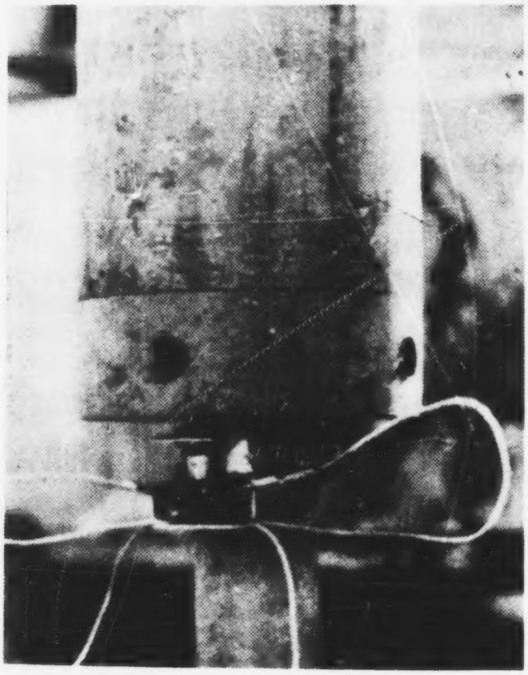


Fig. 1 - (Cont.)

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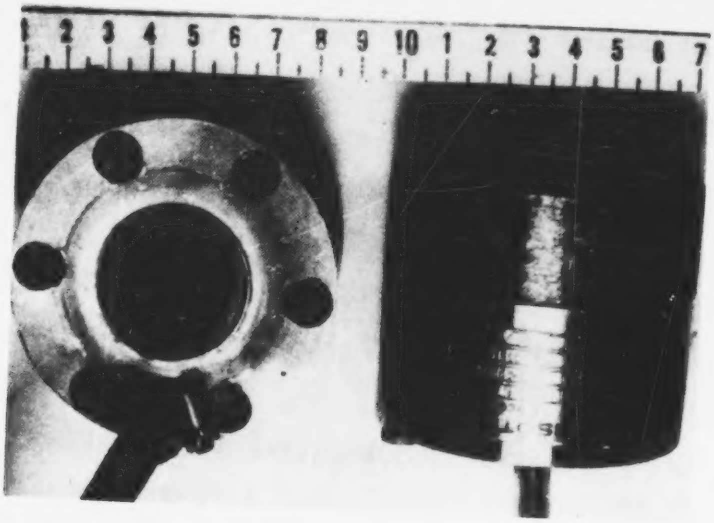
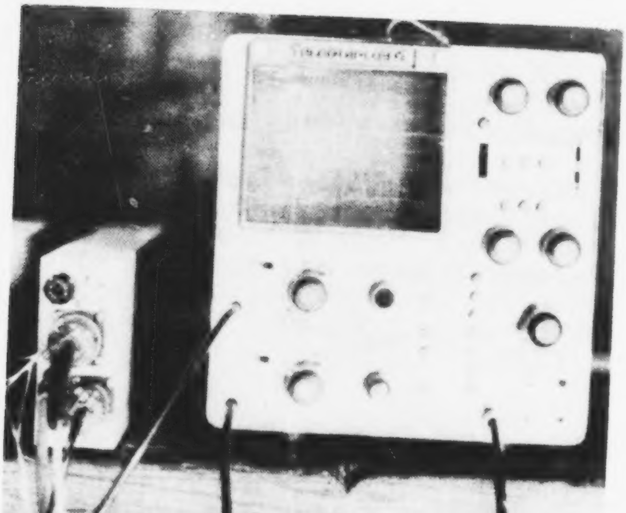
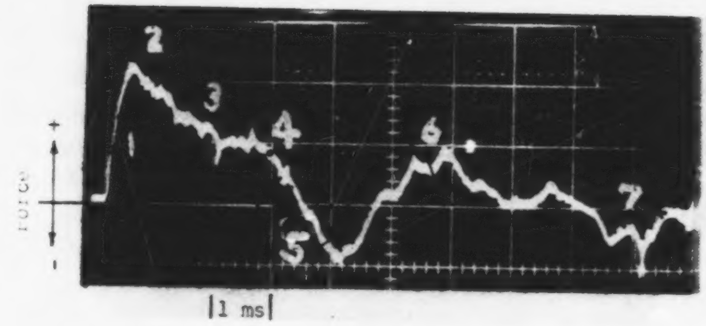


(e) The hollow dynamic load cell, 40,000 lb. capacity, custom made by Sensotic Co.



(f) The load cell signal then put on a storage oscilloscope, photographed, digitized, and integrated for energy content.

Fig. 1 - Continued (1 lb. = 0.45 kg).



(g) Typical oscilloscope force-time record from a single SPT hammer blow. Numbers indicate:

1. Rapid rise of force in initial compression wave.
2. Peak force in this wave - about 21,000 lb.
3. Force decays with successive wave traverses in hammer.
4. Time at which the tension wave reflected from the sampler reaches the load cell. Rods then pull away from the hammer and hammer energy transfer stops.

   Note: $Ei \sim \int_1^4 F^2 \, dt$

5. The first tension wave.
6. The second compression wave after reflection of the tension wave at the top of rods (note reduced energy content compared to first compression stops).
7. The second tension wave, etc.

Fig 1 - Continued (1 lb. = 0.45 kg).

1. The hammer falls impeded by rope-cathead friction and any other energy-absorbing features of the hammer drop system. At the moment of rod impact it has anywhere from about 30 to 80 percent of its supposed energy of 63.5 kg by 76.2 cm (140 lb by 30 in.) = 4840 cm-kg (4200 in.-lb) = E*.

2. Compression waves start simultaneously in the rods and hammer, traveling about 5030 m/s (16,500 ft/s) in both. They reflect as waves of opposite sign (compression-tension-compression, etc.) each time they come to the bottom or top of the rods or hammer. Because of its short length, many more wave traverses take place in the hammer than in the rods. Each time the compression wave pulse in the hammer reaches the hammer-rod contact, some of the hammer wave energy transfers to the rods, with a gradual and stepped decay in the amount per transfer.

3. The aforementioned energy transfer manifests itself in the rods as a compression wave with a short (approximately o.6 ms) rise time to a peak compression stress of about 110,320 kPa (16,000 psi). Then its magnitude decays stepwise with time. These wave properties depend on the rod and hammer materials (steel in cases investigated) but not on rod cross-sectional area. The compression wave then reflects at the sampler and returns as a tension wave but with a net loss of energy to the sampler. When this first tension wave reaches the hammer, the rods pull away from the hammer and the energy imput, E_i, from the hammer stops. With the rope-cathead hammer drop system we find great variability in E_i, with an average E_i equal about 40 percent of E* (18,19). The longer the rods, the greater the hammer-rod contact time and the more hammer energy that enters the rods for possible sampler penetration. Rod lengths less than 6 m (20 ft) cause progressively more significant reductions in hammer energy input because of the progressively earlier separation of rods from the hammer.

4. The compression wave entering the rod depends only on the hammer-rod system. It does not depend on the soil strength properties and therefore does not depend on N. For rod lengths exceeding 6 m (20 ft), 90 + percent of the compression wave energy has already entered the rods before the hammer senses any effect from the soil around the sampler. Soil resistance at the sampler, and therefore the N-value, has virtually no effect on determining E_i.

Because of inevitable energy loss to heat during hammer impact as well as some energy always getting trapped in the anvil, the energy in the hammer at impact must exceed E_i. The energy loss from the impact can equal about 10 to 20 percent of E* (18,19).

5. The sampler does not begin its penetration until the first compression wave reaches the bottom of the sampler. Then it accelerates in about 0.5 ms to a maximum velocity of about 4.5 m/s (15 ft/s), afterward reducing velocity as the wave passes and its force level reduces. The sampler penetrates in decaying surges or cycles of suddenly increased and then decreasing velocity, synchronous with the wave cycles in the rods. The number of such cycles increases with decreasing N because the time required for penetration increases as N decreases, and with decreasing rod length because the time per cycle decreases. By the time the sampler has penetrated to 90 percent of its final set, the average sampler penetration velocity during this 90 percent has reduced to about 1.2 m/s (4 ft/s), with the average velocity when at 90 percent reduced to about 0.45 m/s (1.5 ft/s) (17,20).

6. The time for the sampler to reach 90 percent of its final set under each blow varies inversely with N, taking approximately 10 ms when N = 20 and 40 ms when N = 5.

7. The set/blow, equal to 30 cm/N' (12 in/N'), decreases steadily over the 15 to 45 cm (6 to 18 in.) total penetration to measure N. The set per blow at 45 cm (18 in.) of sampler penetration reduces compared with the set of 15 cm (6 in.) in the same soil and when using the same hammer system delivering the same E_i. This decreases results from the steadily increasing side-friction soil resistance against the sampler. Note that N = N' at 30-cm (12 in.) penetration.

8. To accomplish its penetration, the sampler uses about 80 percent of the rod imput energy, E_i, to overcome dynamic soil resistance. The other 20 percent partly radiates away in soil "quake" and partly gets trapped and dissipates in the rods. N' varies inversely with the energy used, and therefore also approximately inversely with E_i--as expressed by Equation 1.

9. Equation 1, which results from wave equation simulation (17,20) of five typical SPT blows obtained by Palacios (18), expresses the average total end bearing and side-friction dynamic soil resistance to sampler penetration, F_{td}, during its penetration.

$$F_{td}(\text{lb}) \approx 280 \left(\frac{E_i}{E^*}\right) N \text{ (blows/ft)} \qquad (1)$$

The total quasi-static soil resistance at the sampler at our University of Florida research site averaged about 50 percent of the total dynamic resistance in clays and sandy clays, but increased to as high as 60 percent in sands.

What Dynamic Soil Properties Can We Hope to Measure With the SPT?:

It seems to the author that we can only hope to measure those dynamic soil properties where the SPT provides either a direct model of the problem at hand, or the factors that control the behavior of the SPT also similarly control the dynamic property we wish to correlate against. The author suggests the following possibilities.

The Wave Equation Soil Damping Coefficients J_p and J_s:

The driving of the SPT sampler gives us a field test for the driving of a pile. Both involve hammer impact on a one-dimensional rod system to produce a pulsed or cyclic penetration of either pile or sampler into the soil, with the penetration behavior controlled by the stress wave traverses in the pile or sampling rod and the dynamic resistance response of the soil. Many investigators have shown the validity of using the one-dimensional wave equation to analyze real pile-driving problems. Others, notably Adam (21) and McLean et al (22), have recognized that we can also model the SPT behavior with the wave equation. Gallet (20) also did so and had the advantage of having dynamic SPT field data against which to adjust and validate his wave equation model for the SPT. After so doing, and demonstrating that the soil quake generated at the SPT sampler represented a negligible quantity, he could solve the SPT penetration problem with the wave equation and evaluate J_p and J_s. Gallet determined these damping coefficients for a number of SPT blows and obtained values within the range of values usually assumed in pile-driving analyses. The method looks viable.

The J damping coefficients represent major variables in the pile-driving simulation using the wave equation method. More-accurate, site-specific values of J might prove very useful in many applications. In principle, one can estimate these from the SPT using only the ordinary SPT data and the stress wave recorded by a dynamic load cell placed in the string of rods. This load cell should be close to the anvil, but at least 5 rod diameters below it, to allow the wave to recover from the effects of the area reduction from the anvil to rods. It can usually be placed above ground level for convenience, as shown in Fig. 1a and 1b.

Correlation with Factor of Safety Against Liquefaction:

We now know from field experience, and in some cases from controlled laboratory research (2), that all the variables we know of that increase the safety factor against liquefaction occurring also increase dynamic SPT or quasi-static cone penetration resistance. Table 1a summarizes these variables.

The results from the University of Florida research on the dynamics of the SPT can provide additional qualitative arguments to support the possible applicability of the dynamic SPT for the prediction of dynamic liquefaction behavior. Table 1b lists these additional arguments. The SPT produces a pulsed sampler penetration and decaying cycles of loading. The penetration occurs very quickly and must be essentially undrained in all but very coarse soils. The sampler also introduces primarily shear strains into the soil--to match the primarily shear wave propagation assumed to occur under earthquake loading.

Considering the great qualitative similarity between penetration resistance and factor of safety against liquefaction, plus the dynamic and cyclic penetration of the SPT sampler and the dynamic and cyclic production of the liquefaction phenomenon, it seems quite reasonable to expect at least come useful degree of correlation between the SPT N-value and the factor of safety against liquefaction.

Correlation with Shear Wave Velocity:

The shear wave velocity depends on the shear modulus, which in turn depends on the dynamic stress-strain properties of the soil and the level of strain in the traveling shear waves. Because the SPT sampler penetration involves primarily dynamic

TABLE 1a - Qualitative comparison of soil penetration resistance with resistance to liquefaction.

	Effect on	
Factor (after Seed (2))	N-Value	Liquefaction Factor of Safety
1. Greater relative density.	+	+
2. Greater depth (vertical efficiency stress).	+	+
3. Greater horizontal efficiency stresses (OCR or roller compaction).	+	+
4. Cementation, aging phenomena.	+	+
5. Vibration prestraining	+	+
(+ denotes increase)		

Table 1b - Some additional dynamic advantages of the SPT for evaluating liquefaction.

6. Dynamic test to model dynamic behavior.
    a. Rapid penetration: average 1.2 m/s (4 ft/s) 90 percent in 200/N ms.
    b. Pulsed penetration: decays with frequency 8000/depth (ft) Hz.
7. Essentially undrained.
8. High percentage shear wave energy.

Metric conversion: 1 ft. = 0.3048 m.

soil shear behavior, at the failure reference level of shear strain and modulus one can argue that it would be reasonable to expect a correlation between N-values and shear wave velocities at the other reference level of very low strain and maximum modulus.

Figure 2 shows an example from a research site in Florida that indicates such a correlation may exist--at least for a specific site. These data come from Heller (23).

The research site consisted of fine sands, above the water table. Figure 2 shows shear wave velocity profiles with depth using different determination methods and the average N-value profile as determined by Waterways Experiment Station equipment and personnel. It appears we can say that, approximately, V_s (ft/s) = 50 N at this site. The author understands that

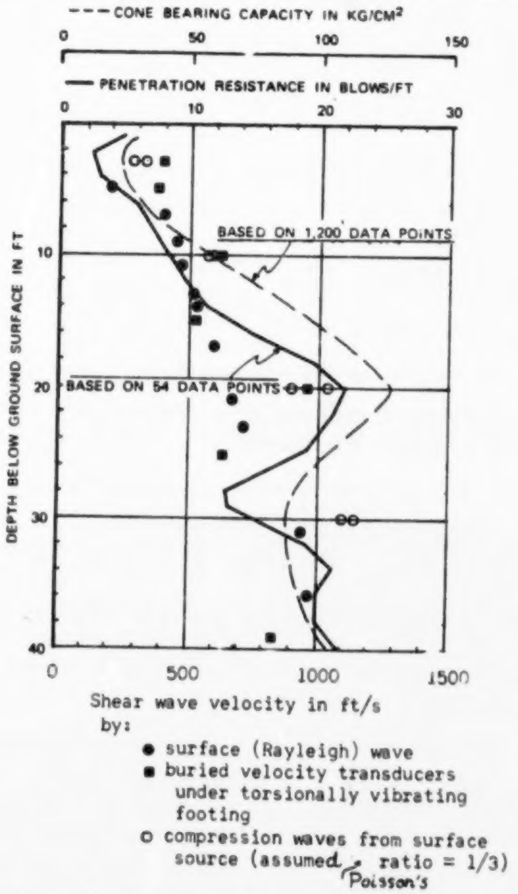


Fig. 2 - Correlation between SPT blowcount, CPT bearing capacity and shear wave velocity in a fine sand above the water table at a site in Northwest Florida (from Heller (23)) (1 kg = 2.2 lb; 1 cm^2 = 0.16 in.^{2} ; 1 ft/s = 0.3 m/s).

the Waterways Experiment Station currently has an active project to more thoroughly explore the possibility of a more general correlation between V_s and N.

As a matter of general interest, Figure 2 also includes the average q_c profile from a large number of Begemann friction-cone penetration tests at the same site. It seems that one could also develop a site correlation between V_s and the static cone bearing capacity, q_c.

First Need to Restandardize the SPT:

From only the previous section of this paper, the reader would perhaps reach an optimistic conclusion about the possible use of SPT N-value data to make useful quantitative predictions of those dynamic soil properties discussed, and perhaps of others not discussed. Unfortunately, the SPT, as practiced in the United States under ASTM Method D 1586, suffers from a perhaps fatal or near-fatal flaw. Practicing engineers know all too well that the test and its N-values have a poor reproducibility and great variability between different operators and equipment. Many investigators, as mentioned earlier, have pointed out this major flaw and give one or more reasons to help explain it. See Schmertmann (24) for a broader discussion of the variability problem.

One need not look far to see why in practice we have such great variability in the test. The author has attempted in Table 2 to organize his digest of the literature and personal opinions as to the causes and magnitude of this variability. He believes that the major causes fall into two categories: variability to the energy that actually enters the sampling rods and travels to the sampler in the form of the first compression wave, and variability in the effective stress conditions at the bottom of the borehole during drilling and sampling.

As Table 2 indicates, these causes can produce major effects which can easily change N by 100 percent. Note that this would also change the factor of safety against liquefaction by 100 percent when using the SPT field method for evaluating the factor of safety. The author considers this an unacceptable situation. The present system negates almost any rational use of the SPT as a quantitative design tool in dynamic as well as in static problems. If we want to use the SPT to its potential for design in problems involving dynamic soil behavior, we must first establish and enforce logical standards for the performance of the SPT. The author offers the following suggestions.

Standardize Energy Entering Rods:

The various works cited earlier have shown convincingly that the energy delivered by the drop weight system presents a major variable in determining N. The work at the University of Florida has shown convincingly that N varies inversely with the compression wave energy that actually enters the sampling rods. We must develop a standard system that introduces as specified compression wave energy into the rods, and that is repeatable all day long in normal operation. It seems obvious that this requires a mechanized drop system that remains independent of operator techniques. With such a system the engineer can adjust the drop height to obtain a fixed amount of compression wave energy, E_i, as determined be appropriate integration of the force-time wave pulse measured by a load cell placed in the rod system a short distance below the hammer. Figure 1 illustrates how researchers at the University of Florida have measured E_i.

Of course, the idea of using a mechanized hammer drop system did not originate here. Some countries have already adopted a mechanized free-drop system as their standard. The paper by Kovacs et al (13) strongly supports the idea of using a mechanized drop system in the United States and details the impact velocity calibration results from such a system presently marketed by a national U.S. distributor.

The author already has some experience with trying to calibrate SPT rigs using the common rope-cathead hammer drop system so as to introduce a standard amount of wave energy delivered into the rods. However, even under the somewhat artifical, especially attentive conditions of a field calibration at a university site, the University of Florida researchers found (19) a ratio of high/low E_i energy delivered from blow to blow by the same operator using his own rig that varied from 1.53 to 1.10, and averaged 1.28 for 10 rigs when considering a random sampling of 5 blows. The author believes that any rig using a rope-cathead hammer drop system remains too operator-dependent to permit its use under a standardized SPT test procedure intended to produce N-values for quantitative design.

TABLE 2 - Some factors in the variability of standard penetration test N.

Cause			Estimated % By Which Cause Can Change N
Basic		Detailed	
Effective stresses at bottom of borehole (sands).	1.	use drilling mud vs. casing & water	+100%
	2.	use hollow-stem auger vs. casing & water & allow head imbalance	±100%
	3.	Small diameter hole (3 in) vs. larger diameter (18 in)	50%
Dynamic energy reaching sample (All Soils)	4.	2 to 3 turn rope-cathead vs. free drop	+100%
	5.	Large vs. small anvil.	+50%
	6.	Length of rods	
		Less than 10 ft	+50%
		30 to 80 ft	0%
		more than 100 ft	+10%
	7.	Variations in height drop	±10%
	8.	A-rods vs. NW-rods	±10%
Sampler Design	9.	Larger ID for liner, but no liners	-10% (sands) -30% (insen. clays)
Penetration Interval	10.	N (0-12 in) instead N (6-18 in)	-15% (sands) -30% (insen. clays)
	11.	N (12-24 in) vs. N (6-18 in)	+15% (sands) +30% (insen. clays)

Metric conversions: 1 ft. = 0.3048 m; 1 in. = 2.45 cm.

Need to Use Drilling Mud:

In the author's opinion, as a practical matter the use of rotary drilling methods with the hole continuously filled with drilling mud to the surface offers the only present way to assure that the effective stress conditions in the sampling zone immediately below the borehole remain as little disturbed as possible by the borehole.

Possible Dual-Standard SPT:

In recognition of the practical difficulties of suddenly adopting a much more rigorous standard for the SPT, involving new equipment with unfamiliar dynamic calibration and possibly unfamiliar drilling techniques, perhaps the profession should again consider a transition period with a dual standard. Chairman Frank Steiger of the SPT task committee for ASTM Committee D-18.02 already proposed a dual standard several years ago.

An SPT performed to say a "Class B" standard would use a calibrated, fully mechanized hammer drop system, and use only rotary drilling and drilling mud. This class would serve for testing in which the engineer intended to use the N-values for important quantitative design, or for research and establishing correlations intended for other than local use. "Class A" SPT work would fall under the continued present standard and allow the great local variability to accommodate local equipment, preferences and correlations.

Conclusions:

1. The profession now has an important new insight into the statics and dynamics of the standard penetration test. Any full understanding of the SPT must include stress wave analysis.

2. A properly standardized SPT has a reasonable, already partly demonstrated potential for quantitative correlations with a factor of safety against liquefaction, with the J damping coefficients in pile-driving problems, and perhaps with high- and low-strain shear wave velocity.

3. The profession needs to establish and enforce an alternative ASTM Method D 1586 standard that requires a mechanized hammer drop, a calibrated energy content in the first compression wave in the rods, and the use of rotary drilling in a hole kept continuously full with drilling mud.

Acknowledgements:

Mr. Alejandro Palacios, Ph.D. student in civil engineering at the University of Florida, performed most of the initial theoretical, equipment development, and field research that led to the successful understanding and measurement of wave and energy phenomena in the SPT. Mr. Alain Gallet, former masters student in civil engineering, made the wave equation simulations of our field SPT data. Dr. David Crapps, former University of Florida (UF) student in civil engineering, assisted Mr. Gallet with the computer simulations. Mr. William J. Whitehead, Assistant in Civil Engineering, provided valuable field technician support. Mr. Julio Palacios, also a UF student, extensively assisted his brother with the field work.

The Florida Department of Transportation and the UF Engineering and Industrial Experiment Station provided the financial support to initiate and complete the research that provides the bases for this paper. The Florida DOT, Universal Engineering and Testing Company, Gainsville, Florida, and Florida Testing Laboratories, Inc., St. Petersburg, Florida, generously donated SPT rigs and crews for the field testing.

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STATIC PILE LOAD TEST MANUAL

BY

Soil Mechanics Bureau
New York State Department of Transportation

Introduction:

This manual establishes uniform statewide procedures for conducting and reporting the results of static pile load tests, in conformance with specification requirements. The primary objectives of static pile load tests are threefold:

1. To establish load-settlement relationships of the pile-soil system,
2. To determine the ultimate load capacity of the pile-soil system, and
3. To determine load distribution in the pile-soil system.

The test will confirm the design assumptions or cause these assumptions to be modified. This may result in reducing or extending the proposed pile length.

Two types of static load tests are described in this manual:

1. The Incremental-Static-Load Test for determining load-settlement relationships and load distribution, and
2. The Constant-Rate-of-Penetration Test for quickly determining ultimate load capacity of the pile-soil system.

The contractor will engage the services of a licensed professional engineer, experienced in all aspects of pile load testing and acceptable to the Deputy Chief Engineer (Structures), to supervise and inspect the load test and to prepare a final report of test results, as outlined in Chapter V of this manual. The contractor's agreement with the licensed professional engineer shall provide for additional technically qualified personnel to be at the test site at all times during testing to assure that the load is being maintained and to record data.

I. PILE TEST LOADS AND LOAD APPLICATION SYSTEMS

Types of Reaction Load:

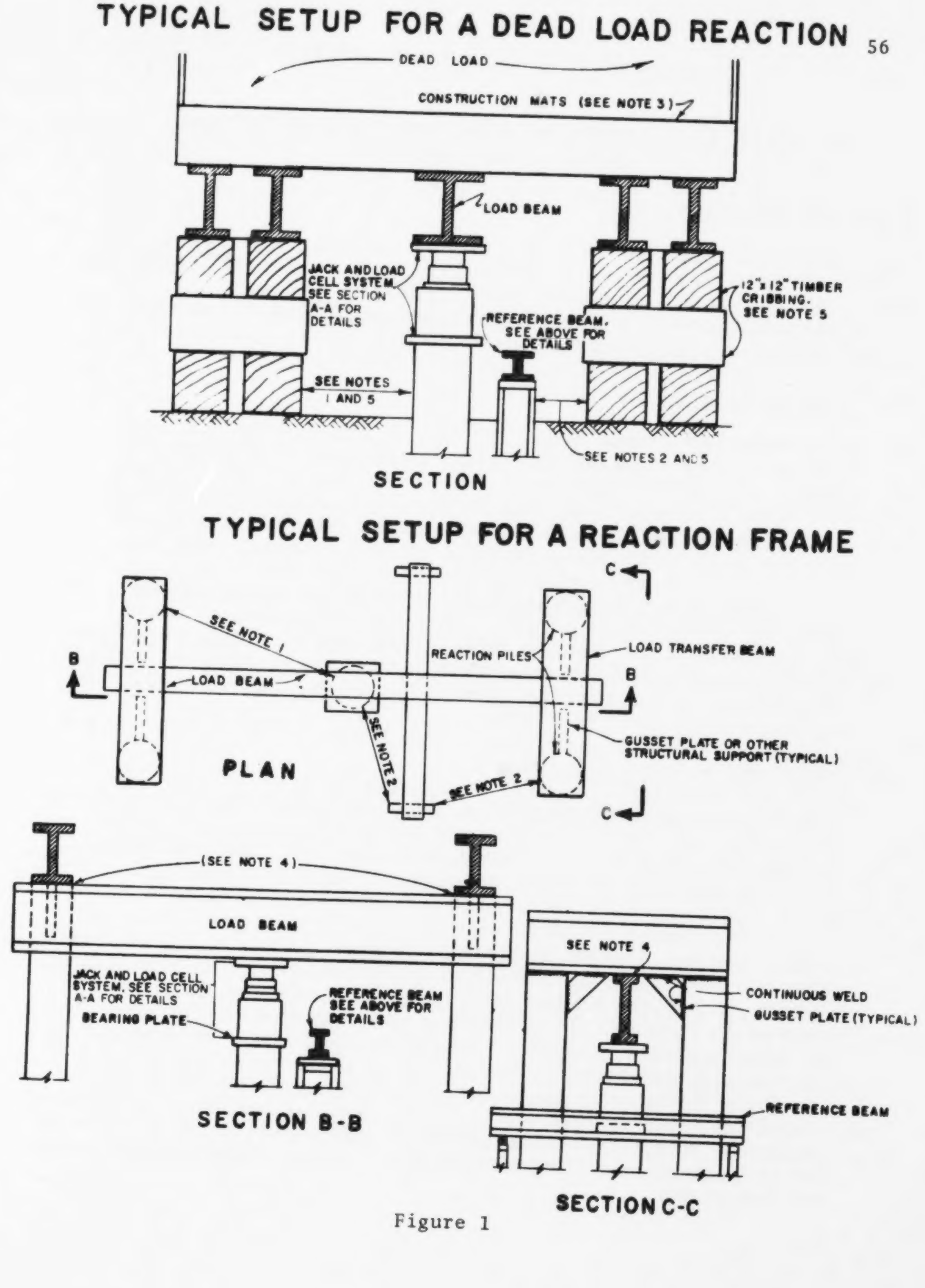
Load shall be applied to the pile by jacking against a reaction with one or more hydraulic jacks. The reaction shall be provided by one of the following two methods, or a variation thereof approved in writing by the Deputy Chief Engineer (Structures).

1. Reaction Frame

   The reaction frame (Fig. 1) shall include two or more anchor piles driven after the test pile. The face of these supports shall be located not less than 10 feet or 10 pile diameters, whichever is greater, from the test pile. Measure these distances between the faces of the test pile and reaction piles. Select girders of sufficient strength and section for the load and load transfer beams which are attached to the upper ends of the anchor piles. This reaction frame shall be capable of resisting four times the maximum pile design load shown on the plans, without undergoing a magnitude of deflection exceeding 75 percent of the maximum travel of the jack.

2. Weighted Box or Platform

   A test box or test platform (Fig. 1) shall be constructed over the test pile, supported on cribbing or on other piles driven after the test pile and located not less than 10 feet or 10 pile diameters, whichever is greater, from the test pile or reference beam supports. Measure these distances between the test pile face and the nearest face of the cribbing or pile supports. Greater spacing of cribbing supports from the test pile reference system may be required to prevent foundation stresses caused by the cribbing from affecting the test pile. If this greater spacing is not feasible due to space or other limitations, a pile supported platform or reaction frame may be necessary. Load the test box or platform with earth, sand, concrete, water, pig iron, or other suitable material to a total weight of at least four times the maximum pile design load shown on the plans.



TYPICAL SETUP FOR A DEAD LOAD REACTION

TYPICAL SETUP FOR A REACTION FRAME

DEAD LOAD
CONSTRUCTION MATS (SEE NOTE 3)
LOAD BEAM
JACK AND LOAD CELL SYSTEM. SEE SECTION A-A FOR DETAILS
12"x12" TIMBER CRIBBING. SEE NOTE 5
REFERENCE BEAM. SEE ABOVE FOR DETAILS
SEE NOTES 1 AND 5
SEE NOTES 2 AND 5
SECTION
C
SEE NOTE 1
B
LOAD BEAM
REACTION PILES
LOAD TRANSFER BEAM
B
SEE NOTE 2
GUSSET PLATE OR OTHER STRUCTURAL SUPPORT (TYPICAL)
PLAN
SEE NOTE 2
C
(SEE NOTE 4)
LOAD BEAM
JACK AND LOAD CELL SYSTEM. SEE SECTION A-A FOR DETAILS
BEARING PLATE
REFERENCE BEAM SEE ABOVE FOR DETAILS
SECTION B-B
SEE NOTE 4
CONTINUOUS WELD
GUSSET PLATE (TYPICAL)
REFERENCE BEAM
SECTION C-C

Figure 1

TYPICAL SETUP FOR MEASURING SYSTEMS

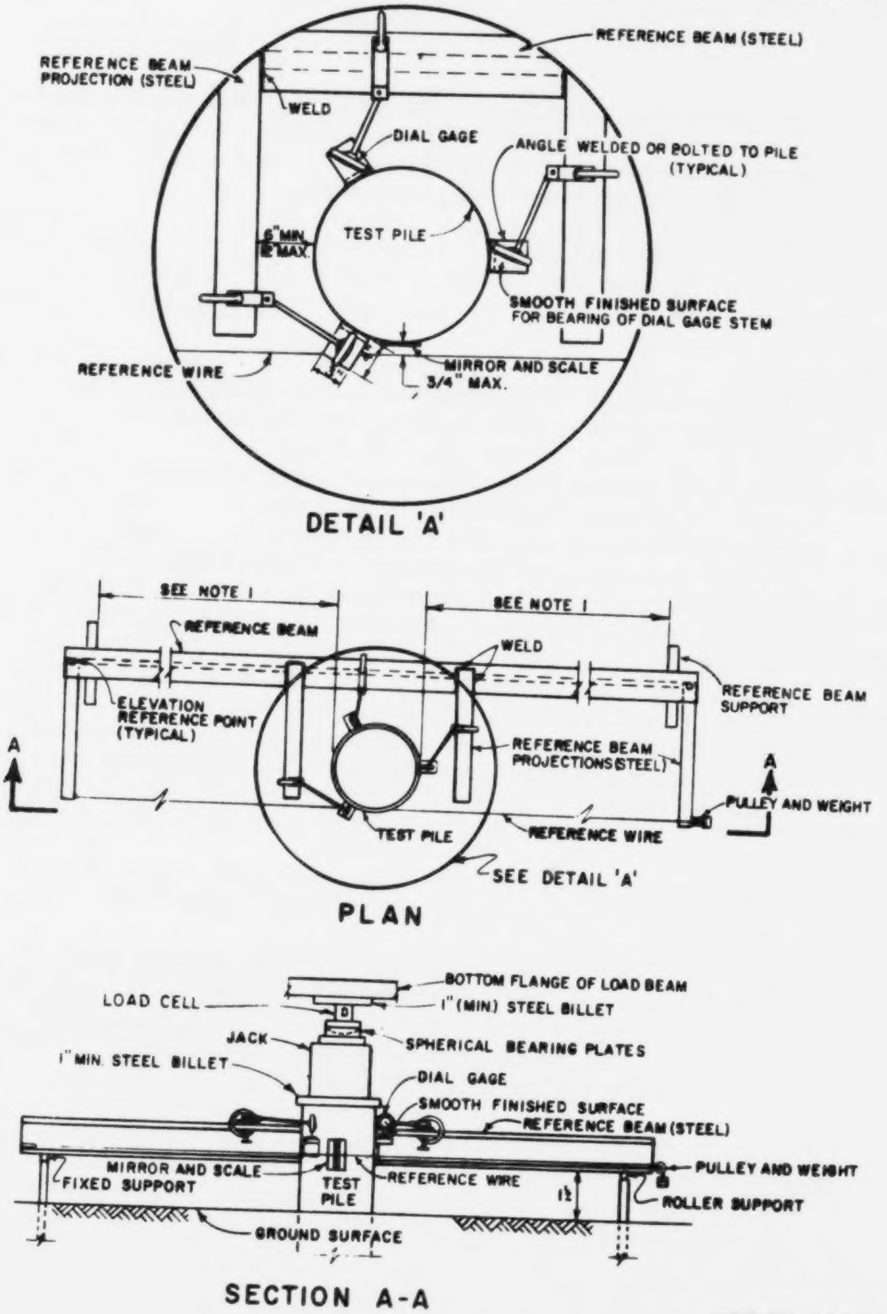

REFERENCE BEAM (STEEL)
REFERENCE BEAM PROJECTION (STEEL)
WELD
DIAL GAGE
ANGLE WELDED OR BOLTED TO PILE (TYPICAL)
6" MIN. 12" MAX.
TEST PILE
SMOOTH FINISHED SURFACE FOR BEARING OF DIAL GAGE STEM
REFERENCE WIRE
MIRROR AND SCALE
3/4" MAX.
DETAIL 'A'
SEE NOTE I
SEE NOTE I
REFERENCE BEAM
WELD
REFERENCE BEAM SUPPORT
ELEVATION REFERENCE POINT (TYPICAL)
A
REFERENCE BEAM PROJECTIONS (STEEL)
A
PULLEY AND WEIGHT
TEST PILE
REFERENCE WIRE
SEE DETAIL 'A'
PLAN
BOTTOM FLANGE OF LOAD BEAM
LOAD CELL
1" (MIN.) STEEL BILLET
JACK
SPHERICAL BEARING PLATES
1" MIN. STEEL BILLET
DIAL GAGE
SMOOTH FINISHED SURFACE
REFERENCE BEAM (STEEL)
MIRROR AND SCALE
FIXED SUPPORT
TEST PILE
REFERENCE WIRE
1½
PULLEY AND WEIGHT
ROLLER SUPPORT
GROUND SURFACE
SECTION A-A
NOT TO SCALE

Figure 1 (cont.)

NOTES

1. The minimum distance between the face of the test pile and the face of any supports for reaction loads or measurement systems shall be ten feet or ten test pile diameters whichever is greater.
2. The minimum distance between the face of any reaction supports and any supports for the measurement system shall be ten feet or ten test pile diameters whichever is greater.
3. Dead load may be supported on construction mats, steel beams or other suitable structural members.
4. The load beam for this type of reaction may bear on the load transfer beams with no connections. The load beam may need stiffeners at the points of bearing. The beam may also require truss work (not shown) to prevent excessive bending and resulting ram extension in excess of seventy-five (75) percent of the maximum travel of the jack.
5. The pressure intensity exerted on the ground surface from the cribbing must not exceed the bearing capacity of the soil or cause settlement of the test pile and/or measurement system.

TYPICAL SETUP DETAILS
FOR
Reaction Loads, Measuring
and Loading Systems
Figure 1

3. Alternate Methods

   The contractor may request approval for applying the reaction load by another method. In this case the contractor shall submit in writing a summary of the alternate loading system with appropriately detailed drawings for approval by the Deputy Chief Engineer (Structures).

Load Application System:

The load shall be applied by means of one or more hydraulic jacks, having a capacity of at least four times the maximum pile design load shown on the plans. Travel of the jack(s) shall be a minimum of 6 inches, and in no case less than 25 percent of the test pile's maximum cross section dimension. The jack(s) shall have spherical bearing plates, to bear firmly and concentrically against the pile bearing plate and load-beam bearing plate. Load application shall be controlled by an automatic load maintaining pump with manual supplement. The system's pressure gage shall be such that the pressure reading corresponding to the maximum pile design load shown on the plans shall be between one-fourth and one-third the maximum gage pressure. A load cell either electric or hydraulic (unless either type is specifically called for in the contract documents) shall be located as shown in Fig. 1 and shall be utilized to record strains for load monitoring during the load test(s).

The load-application system shall consist of several elements, arranged and constructed as follows:

1. The pile top shall be cut off and capped so as to provide a level bearing surface perpendicular to the axis of the pile. The cap shall consist of a steel plate for H-piles and a neat cement paste for concrete piles, timber piles, or cast-in-place piles filled with concrete;

2. Use a solid steel billet, of sufficient thickness (under no circumstances less than 1 inch) as a bearing plate between the capped pile and the jack base, to distribute the load over the entire cross-section of the pile;

3. Place the hydraulic jack system (jack spherical bearing plate and load cell) between the bearing plate on the pile and the center of the underside of the load beam;

4. Use another solid steel billet, of sufficient thickness (under no circumstances less than 1 inch) as a bearing plate between the load beam and the jack ram, to distribute the load over the entire width of the load beam;

5. Construct the system so that all components are centered along the longitudinal axis of the pile to assure the application of a concentric axial load;

6. Immediately before starting the load test, verify that at least 1 inch of clear space exists between the upper bearing place and the load beam.

II. MEASURING APPARATUS AND SITE PROTECTION

The apparatus for measuring settlement shall consist of a primary system, at least one auxiliary system, and a network of settlement reference points. Two fixed independent bench marks shall also be establsihed at least 50 feet from the test site to monitor the settlement reference points. The auxiliary system may also be referenced to these bench marks, if desired. All dial gages, scales, and reference points shall be clearly marked with numbers of letter to assist in recording data accurately.

Primary System:

1. Dial Gages (Fig. 1)

   The contractor shall provide a primary system consisting of three dial gages for monitoring movement of the pile top. The gages shall have at least 2 inches of travel, an adequate number of suitable gage blocks to increase the travel to at least an additional 4 inches, and a precision of 0.001 inches.

   Align the dial gages parallel to the longitudinal axis of the test pile and the axis of load application. Attach the gages to a simply supported reference beam, which is to be completely independent of the test pile and the loading apparatus. Embed the reference beam supports at least 10 feet into the ground, at a horizontal distance of not less than 10 feet or 10 pile diameters, whichever is greater, from the closest face of the test pile and from any reaction piles or supports for the weighted box or platform. Maintain a clear distance of 6 to 12 inches from the test pile to the reference beam or any projections should be at approximately the same elevation as the attachments to the pile on which the dial gages will bear. Attach the dial gage supports to the reference beam so as to allow the stem of each gage to rest on an attachment to the pile sides. These attachments shall be steel angles, approximately 3- by 4-inch with the 4-inch dimension projecting from the pile. For round piles, these attachments shall be placed at 120° spacing and equal radial distance from the test pile. For piles of other cross-section, the attachments shall be placed at convenient locations as approved by the Engineer. The surfaces on which the gage stems bear should be smooth-finished, such as glass or sheet acrylic, attached by plaster of paris or other suitable material.

2. Telltale Strain Measurements (Figs. 2, 3, and 4)

Strain measurements on the pile may be required by a special note in the contract documents. These measurements are for determining elastic shortening of the pile. Telltales may be required at one or more points along the pile as shown on the plans or designated by the Deputy Chief Engineer (Structures). Attach the telltale dial gages to the reference beam. The gage readings will be used to determine net settlement of the point(s) of investigation.

Auxiliary Systems:

These measuring systems shall consist of one or more of the following: wire, mirror, and scale; surveyor's level and target rod; or, as alternates, electrical or optical levels.

1. Wire, Mirror, and Scale (Fig. 1)

Pile movement may be determined by means of a single strand of wire drawn in front of a graduated scale mounted on a mirror. This scale shall be at least 6 inches long, machine-divided in graduations of 0.01 inches and mounted on a 3 by 6 inch mirror with metal-and-glass bonding adhesive or electrical tape. Attach the mirror directly

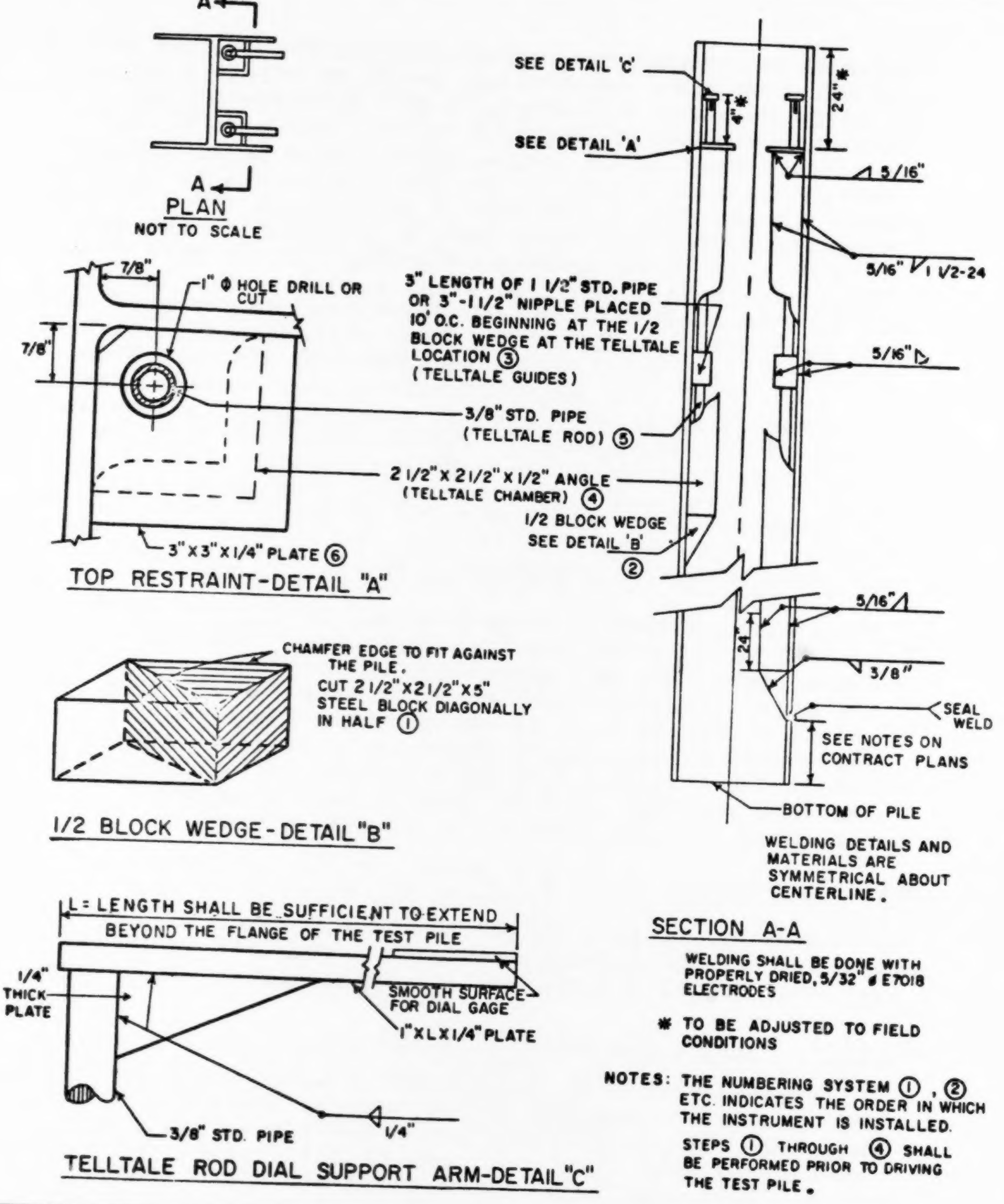
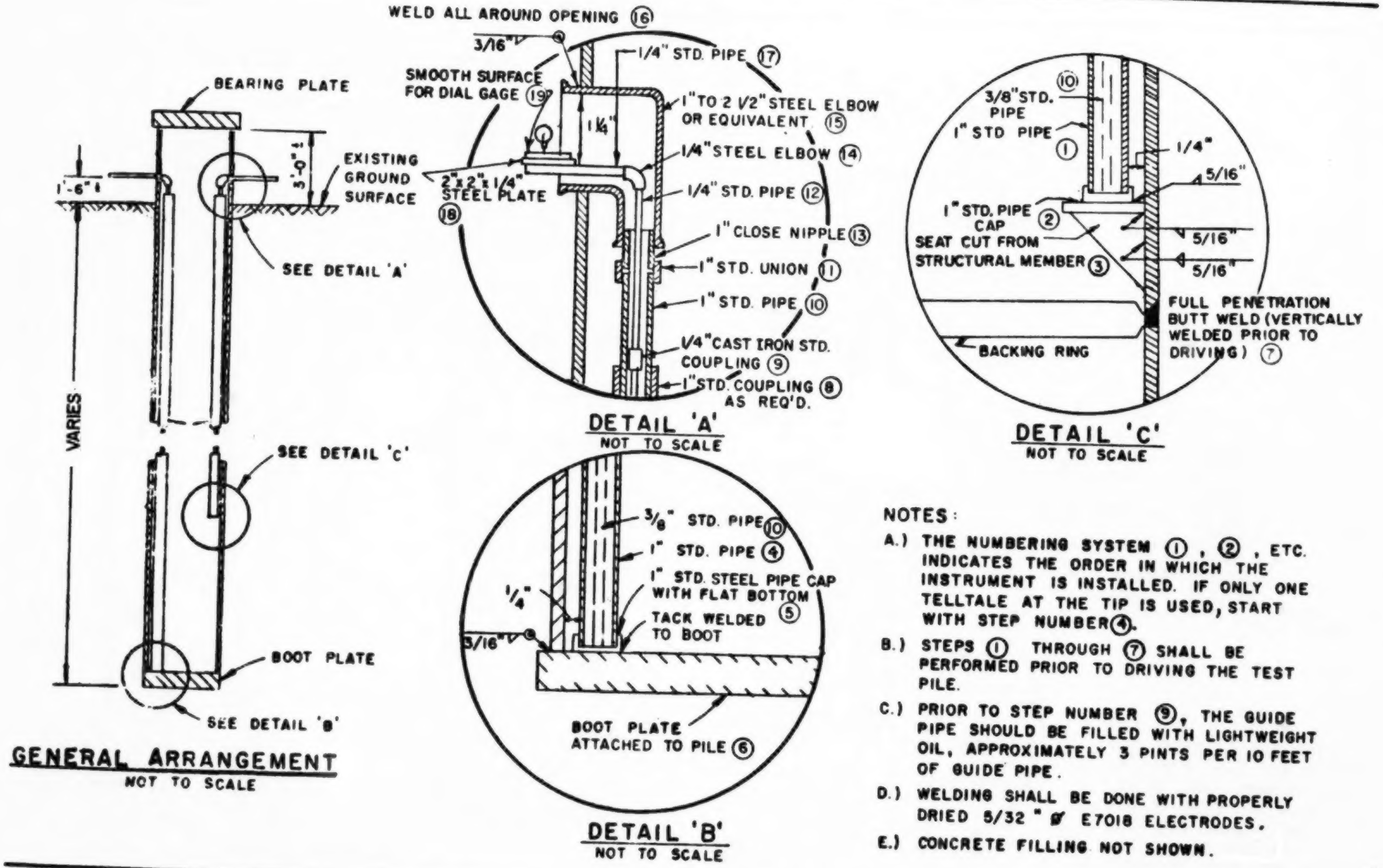

A
A
PLAN
NOT TO SCALE
7/8"
7/8"
1" Φ HOLE DRILL OR CUT
3/8" STD. PIPE (TELLTALE ROD) ⑤
2 1/2" X 2 1/2" X 1/2" ANGLE (TELLTALE CHAMBER) ④
3" X 3" X 1/4" PLATE ⑥
TOP RESTRAINT-DETAIL "A"
CHAMFER EDGE TO FIT AGAINST THE PILE.
CUT 2 1/2" X 2 1/2" X 5" STEEL BLOCK DIAGONALLY IN HALF ①
1/2 BLOCK WEDGE-DETAIL "B"
L = LENGTH SHALL BE SUFFICIENT TO EXTEND BEYOND THE FLANGE OF THE TEST PILE
1/4" THICK PLATE
SMOOTH SURFACE FOR DIAL GAGE
1" X L X 1/4" PLATE
3/8" STD. PIPE
1/4"
TELLTALE ROD DIAL SUPPORT ARM-DETAIL "C"
SEE DETAIL 'C'
SEE DETAIL 'A'
4"*
24"*
5/16"
5/16" 1 1/2-24
3" LENGTH OF 1 1/2" STD. PIPE OR 3"-1 1/2" NIPPLE PLACED 10' O.C. BEGINNING AT THE 1/2 BLOCK WEDGE AT THE TELLTALE LOCATION ③ (TELLTALE GUIDES)
5/16"
1/2 BLOCK WEDGE SEE DETAIL 'B' ②
5/16"
24
3/8"
SEAL WELD
SEE NOTES ON CONTRACT PLANS
BOTTOM OF PILE
WELDING DETAILS AND MATERIALS ARE SYMMETRICAL ABOUT CENTERLINE.
SECTION A-A
WELDING SHALL BE DONE WITH PROPERLY DRIED, 5/32" ø E7018 ELECTRODES
* TO BE ADJUSTED TO FIELD CONDITIONS
NOTES: THE NUMBERING SYSTEM ①, ② ETC. INDICATES THE ORDER IN WHICH THE INSTRUMENT IS INSTALLED.
STEPS ① THROUGH ④ SHALL BE PERFORMED PRIOR TO DRIVING THE TEST PILE.

Figure 2. Telltale details for steel H-piles.


WELD ALL AROUND OPENING ⑯
3/16"
SMOOTH SURFACE FOR DIAL GAGE ⑲
1/4" STD. PIPE ⑰
1" TO 2 1/2" STEEL ELBOW OR EQUIVALENT ⑮
1/4" STEEL ELBOW ⑭
1/4" STD. PIPE ⑫
1" CLOSE NIPPLE ⑬
1" STD. UNION ⑪
1" STD. PIPE ⑩
1/4" CAST IRON STD. COUPLING ⑨
1" STD. COUPLING ⑧ AS REQ'D.
2"x2"x1/4" STEEL PLATE ⑱
1 1/4"
BEARING PLATE
EXISTING GROUND SURFACE
3'-0" ±
1'-6" ±
SEE DETAIL 'A'
VARIES
SEE DETAIL 'C'
BOOT PLATE
SEE DETAIL 'B'
GENERAL ARRANGEMENT
NOT TO SCALE
DETAIL 'A'
NOT TO SCALE
3/8" STD. PIPE ⑩
1" STD. PIPE ④
1" STD. STEEL PIPE CAP WITH FLAT BOTTOM
TACK WELDED TO BOOT ⑤
1/4"
3/16"
BOOT PLATE ATTACHED TO PILE ⑥
DETAIL 'B'
NOT TO SCALE
⑩
3/8" STD. PIPE
1" STD PIPE ①
1/4"
5/16"
1" STD. PIPE CAP ②
SEAT CUT FROM STRUCTURAL MEMBER ③
5/16"
5/16"
FULL PENETRATION BUTT WELD (VERTICALLY WELDED PRIOR TO DRIVING) ⑦
BACKING RING
DETAIL 'C'
NOT TO SCALE

NOTES:

A.) THE NUMBERING SYSTEM ①, ②, ETC. INDICATES THE ORDER IN WHICH THE INSTRUMENT IS INSTALLED. IF ONLY ONE TELLTALE AT THE TIP IS USED, START WITH STEP NUMBER ④.

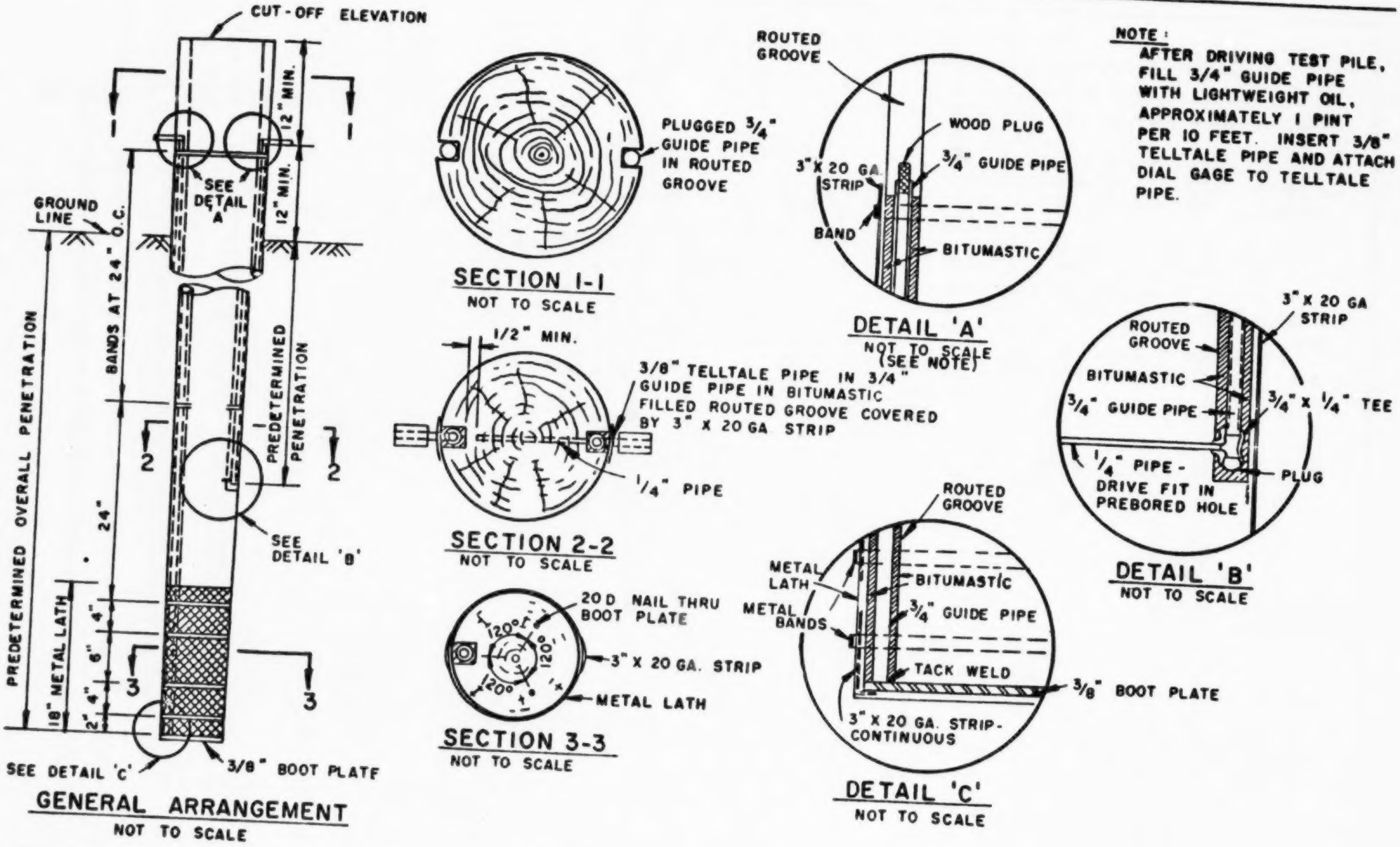
B.) STEPS ① THROUGH ⑦ SHALL BE PERFORMED PRIOR TO DRIVING THE TEST PILE.

C.) PRIOR TO STEP NUMBER ⑨, THE GUIDE PIPE SHOULD BE FILLED WITH LIGHTWEIGHT OIL, APPROXIMATELY 3 PINTS PER 10 FEET OF GUIDE PIPE.

D.) WELDING SHALL BE DONE WITH PROPERLY DRIED 5/32" Ø E7018 ELECTRODES.

E.) CONCRETE FILLING NOT SHOWN.

Figure 3. Telltale details for cast-in-place piles.


CUT-OFF ELEVATION
GROUND LINE
12" MIN.
12" MIN.
SEE DETAIL 'A'
BANDS AT 24" O.C.
PREDETERMINED OVERALL PENETRATION
PREDETERMINED PENETRATION
2
2
24"
SEE DETAIL 'B'
18" METAL LATH
4"
6"
4"
2"
3
3
SEE DETAIL 'C'
3/8" BOOT PLATF
GENERAL ARRANGEMENT
NOT TO SCALE
PLUGGED 3/4" GUIDE PIPE IN ROUTED GROOVE
SECTION 1-1
NOT TO SCALE
1/2" MIN.
3/8" TELLTALE PIPE IN 3/4" GUIDE PIPE IN BITUMASTIC FILLED ROUTED GROOVE COVERED BY 3" X 20 GA STRIP
1/4" PIPE
SECTION 2-2
NOT TO SCALE
20 D NAIL THRU BOOT PLATE
120°
120°
120°
3" X 20 GA. STRIP
METAL LATH
SECTION 3-3
NOT TO SCALE
ROUTED GROOVE
WOOD PLUG
3/4" GUIDE PIPE
3" X 20 GA. STRIP
BAND
BITUMASTIC
DETAIL 'A'
NOT TO SCALE (SEE NOTE)
ROUTED GROOVE
METAL LATH
METAL BANDS
BITUMASTIC
3/4" GUIDE PIPE
TACK WELD
3/8" BOOT PLATE
3" X 20 GA. STRIP-CONTINUOUS
DETAIL 'C'
NOT TO SCALE
3" X 20 GA STRIP
ROUTED GROOVE
BITUMASTIC
3/4" GUIDE PIPE
3/4" X 1/4" TEE
1/4" PIPE - DRIVE FIT IN PREBORED HOLE
PLUG
DETAIL 'B'
NOT TO SCALE

NOTE:
AFTER DRIVING TEST PILE, FILL 3/4" GUIDE PIPE WITH LIGHTWEIGHT OIL, APPROXIMATELY 1 PINT PER 10 FEET. INSERT 3/8" TELLTALE PIPE AND ATTACH DIAL GAGE TO TELLTALE PIPE.

Figure 4. Telltale details for timber piles.

to the pile, so oriented that the mirror face is parallel to the reference beam. Mount the wire between the ends of the reference beam, with one end fixed and the other placed over a pulley with a weight to maintain tension. The wire should be level and located within 3/4 inches of the mirror face.

2. Surveyor's Level and Target Rod

A level and leveling rod with a vernier target that can be read to 0.001 foot may be used. Determine settlements by readings on the two fixed independent bench marks, and on an established scale or fixed point on the pile top.

3. Alternate Systems

Any other type of electrical or optical gage yielding a precision equivalent to the primary system is acceptable as an alternate, provided prior written approval is obtained from the Deputy Chief Engineer (Structures).

Settlement Reference Points:

The contractor shall establish reference points on the test pile, at each end of the reference beam, and on each of the reaction piles (if used). Recommended locations and materials are as follows:

1. On the reference beam:
    a. Round-head bolt,
    b. Round bead of weld about 1/4 inches high.
2. One the test piles:
    a. Lug on the side about 1 inch from the top,
    b. Bead of weld on the steel billet.
3. On the reaction piles:
    a. Cut mark made by hacksaw,
    b. Lug welded to the pile.

The engineer-in-charge shall establish the elevation of these reference points with respect to the two fixed independent bench marks.

Protection of the Site:

The contractor shall provide complete protection at all times for the pile, supports, and reference beam from wind, direct sunlight, frost action, and other disturbances. The contractor shall also maintain a temperature of not less than 50°F throughout the duration of the test and provide a thermometer to monitor temperature. To accomplish this, it may be necessary to provide heat and to construct a suitable test enclosure of fiber board, polythylene, canvas, or other materials acceptable to the engineer-in-charge. The contractor shall provide adequate lighting for the duration of the test.

III. PROCEDURE FOR THE INCREMENTAL-STATIC-LOAD TEST

Test Procedure:

1. Waiting Period

Immediately after the test pile has been driven, the contractor shall establish the elevation of the pile top. The contractor must take all necessary precautions to prevent upward movement or rebound of the pile (pile heave) before the load test begins. Pile heave is caused by high pore pressures built-up during driving, especially in fine-grained soils. The contractor may wish to obtain pile top measurements during the waiting period to detect pile heave. In any case, a final pile top elevation shall be taken prior to commencing the load test. If this elevation differs by more than 0.1 inches from the pile top elevation immediately after driving the load test shall be suspended and the Deputy Chief Engineer (Structures) immediately notified. Corrective action may require the contractor to redrive the pile and provide an additional waiting period during which pile heave is restrained prior to the test.

A minimum waiting period of 7 days or as otherwise defined in the contract documents, shall be observed between driving the last pile in the load test system and commencing the test. The load test system may be set up during this period, using one of the reaction load methods described in Chapter I or an approved alternate. The primary and auxiliary systems of measurement may also be set up during this period. Before commencing the test, the contractor shall record all initial readings and establish the elevations of the settlement reference points.

2. Special Procedure for Cast-in-Place Piles

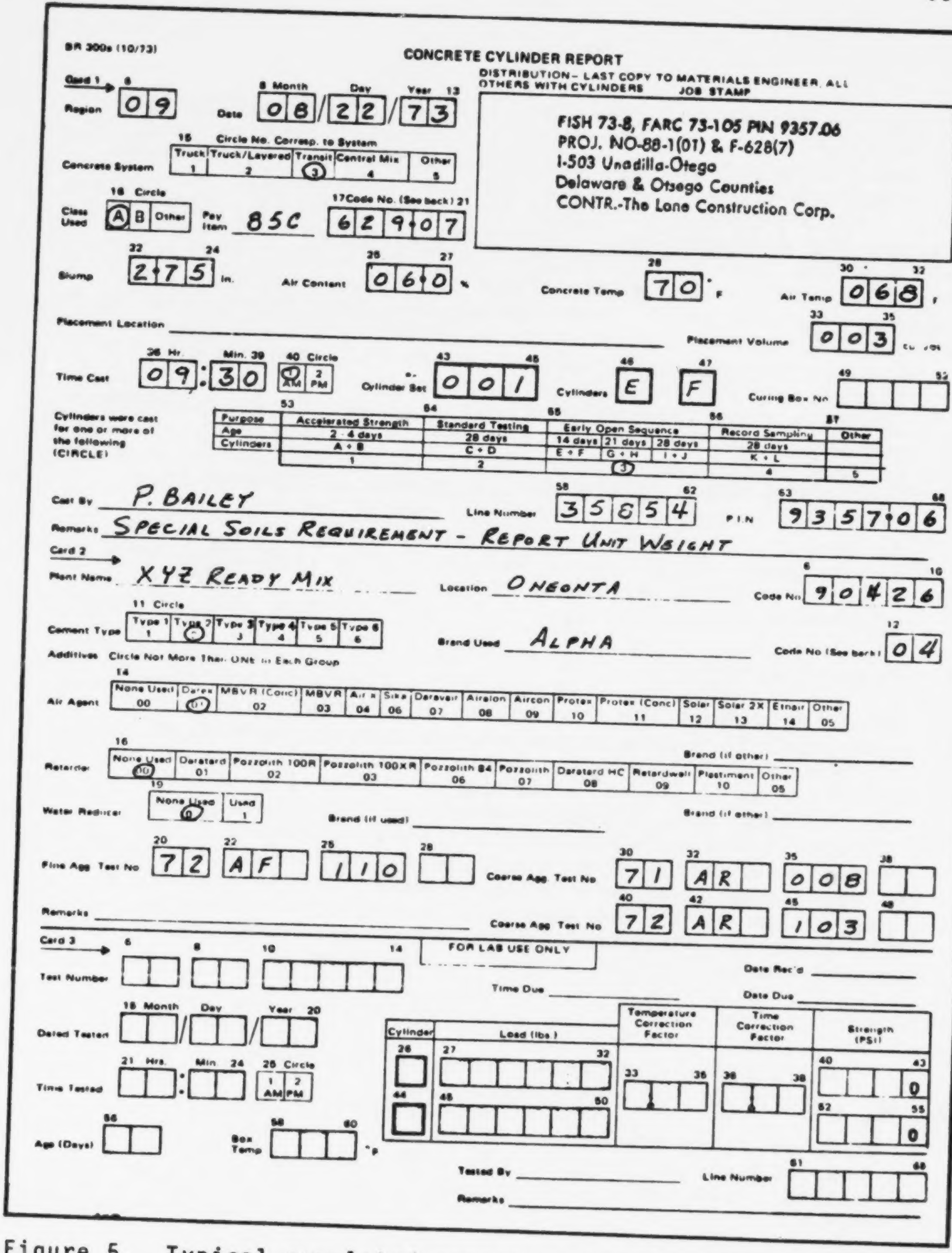
All cast-in-place piles shall be filled with concrete and a period of at least seven days observed before load testing, unless otherwise specified in the contract documents or ordered by the Deputy Chief Engineer (Structures). Three sets of concrete cylinders (1 set = 2 cylinders) shall be cast in accordance with the Department's Materials Method 9.2 ("Field Inspection of Portland Cement Concrete."). Test in accordance with the "Early Open Sequence" designated on Form BR 300a (Fig. 5). Card 1 on this form should include the following statement under "Remarks": "Special Soils Requirement--Report Unit Weight." The test results will be used to determine the modulus of elasticity. of the concrete filling.

3. Loading Procedure

Load and unload the test pile incrementally in three cycles, unless an alternate procedure is specified in the contract documents. Apply each load increment to the pile in as short a period as physically possible. The maximum load applied shall be twice the maximum pile design load shown on the plans, unless failure as defined in III C occurs first. The required load after application of each increment is expressed as a percentage of the maximum pile design load shown on the plans or specified in the contract documents. The three loading cycles are as follows:

Incremental Load Test

Cycle	Magnitude and Sequence of Load Increments, percent of maximum design load
1	0, 50, 100, 50, 0
2	0, 50, 100, 125, 150, 175, 200, 150, 100, 50, 0
3	0, 50, 100, 150, 200 (24 hr. hold), 150, 100, 50, 0



BR 300a (10/73)

CONCRETE CYLINDER REPORT

DISTRIBUTION – LAST COPY TO MATERIALS ENGINEER. ALL OTHERS WITH CYLINDERS

JOB STAMP

FISH 73-8, FARC 73-105 PIN 9357.06
PROJ. NO-88-1(01) & F-628(7)
I-503 Unadilla-Otego
Delaware & Otsego Counties
CONTR.-The Lone Construction Corp.

Card 1 →

Region: 09

Date: Month 08 / Day 22 / Year 73

Concrete System (Circle No. Corresp. to System): Truck 1, Truck/Layered 2, [✓ Transit 3], Central Mix 4, Other 5

Class Used (Circle): [✓ A], B, Other

Pay Item: 85C

Code No. (See back): 629.07

Slump: 2.75 in.

Air Content: 06.0 %

Concrete Temp: 70 °F

Air Temp: 068 °F

Placement Location: ______

Placement Volume: 003 cu. yds

Time Cast: Hr. 09 : Min. 30 (Circle) [✓ 1 AM] 2 PM

Cylinder Set: 001

Cylinders: E F

Curing Box No: ______

Cylinders were cast for one or more of the following (CIRCLE)

Purpose	Accelerated Strength	Standard Testing	Early Open Sequence			Record Sampling	Other
Age	2 - 4 days	28 days	14 days	21 days	28 days	28 days	
Cylinders	A + B	C + D	E + F	G + H	I + J	K + L	
	1	2		[✓ 3]		4	5

Cast By: P. BAILEY

Line Number: 35854

P.I.N.: 9357.06

Remarks: SPECIAL SOILS REQUIREMENT - REPORT UNIT WEIGHT

Card 2 →

Plant Name: XYZ READY MIX

Location: ONEONTA

Code No: 90426

Cement Type (Circle): Type 1 1, [✓ Type 2 2], Type 3 3, Type 4 4, Type 5 5, Type 6 6

Brand Used: ALPHA

Code No (See back): 04

Additives: Circle Not More Than ONE in Each Group

Air Agent:

None Used	Darex	MBVR (Conc)	MBVR	Air x	Sika	Daravair	Airalon	Aircon	Protex	Protex (Conc)	Solar	Solar 2X	Etnair	Other
00	[✓ 01]	02	03	04	06	07	08	09	10	11	12	13	14	05

Brand (if other): ______

Retarder:

None Used	Daratard	Pozzolith 100R	Pozzolith 100XR	Pozzolith 84	Pozzolith	Daratard HC	Retardwell	Plastiment	Other
[✓ 00]	01	02	03	06	07	08	09	10	05

Water Reducer: [✓ None Used 0], Used 1

Brand (if used): ______

Brand (if other): ______

Fine Agg. Test No: 72 AF 110

Coarse Agg. Test No: 71 AR 008

Coarse Agg. Test No: 72 AR 103

Remarks: ______

Card 3 →

FOR LAB USE ONLY

Test Number: ______

Date Rec'd: ______

Time Due: ______

Date Due: ______

Dated Tested: Month __ / Day __ / Year __

Time Tested: Hrs. __ : Min __ (Circle) 1 AM 2 PM

Age (Days): ______

Box Temp: ______ °F

Cylinder	Load (lbs.)	Temperature Correction Factor	Time Correction Factor	Strength (PSI)
				0
				0

Tested By: ______

Line Number: ______

Remarks: ______

Figure 5. Typical completed report on test of concrete filling a cast-in-place pile.

Maintain each load increment until the settlement rate under the applied load, or rate of rebound from the previous load increment, is less the 0.001 inches in 15 minutes. The minimum period for maintaining a load increment, however, will be 30 minutes and an increment may be removed after having been maintained for 2 hours, regardless of the rate of settlement or rebound. When 200 percent of the design load has been applied during Cycle 3, provided the pile has not failed, leave this load in place for 24 hours. When the pile has rebounded to zero load at the end of Cycle 3, maintain zero load at least 1 hour. Maintain each load constantly and note any adjustments to the jack in the "Remarks" column on the time-settlement data sheet (Form SM 380a).

Upon failure, the Deputy Chief Engineer (Structures) shall immediately be notified by telephone and given all pertinent details of the load test(s). The Deputy Chief Engineer (Structures) will notify the contractor within one working day whether Cycle 3 is required and to what maximum load the pile is to be reloaded for Cycle 3 of the loading sequence.

The Deputy Chief Engineer (Structures) will notify the contractor within 2 days relative to the need for an additional load test in the event that Cycle 3 of the loading procedure is cancelled.

Data Collection:

The contractor shall read and record time-settlement data on Form SM 380a (supplied by the Engineer-in-Charge) in accordance with the following:

1. Top Deflection Measurement

   Read movement to the nearest 0.001 inches before and after application of a new load increment or removal of an increment already in place. Additionally, after application of all loads, except the 200 percent load, or removal of an increment, take readings at 1/2, 1, 2, 4, 8, 15, and 30 minutes, and every 15 minutes thereafter for 2 hours or until the next increment is applied or removed. During the 24-hour hold of the 200 percent load, however, read settlement every 3 hours after the first 2 hours of readings.

2. Telltale Strain Indicators

Read movement to the nearest 0.001 inch before and after application or removal of each load increment. During the 24-hour hold, read the telltale immediately after the load is applied, 2 hours later, and every 3 hours thereafter until the load is removed.

3. Auxiliary Systems

   a. Wire, Mirror, and Scale: Read to the nearest 0.01 inch before and after each application or removal of a lead increment, by visually aligning the top of the wire with both its reflection in the mirror and the scale mounted on the mirror.

   b. Rod and Level: Read to the nearest 0.001 foot immediately before and as soon as practicable after application of removal of each load increment.

4. Settlement Reference Points

Check settlement to a precision of 0.001 foot on the reference points described in Chapter III, as follows:

a. Immediately before the test,
b. Immediately before rebounding from 100 percent of the design load (all cycles),
c. Immediately before rebounding from 200 percent of the design load (both cycles), and
d. At the end of the test, after the final rebound reading.

If readings on the reference points vary by more than 0.005 foot from their inititial readings, or if a reading on the pile head varies by more the 0.005 foot from the deflection shown by the primary system, set up the level in another location and check the elevations. Continue this procedure until two sets of consistent level readings are obtained. If these two sets still differ by more than 0.005 foot from either initial readings for the point on the test pile, halt the test until the discrepancy has been explained and adjusted.

5. System Check

If discrepancies occur as described in Chapter III, B, 4., the Engineer-in-Charge shall halt the test and notify the Deputy Chief Engineer (Structures) by telephone. The test shall not be resumed until the system(s) has been corrected to the satisfaction of the Deputy Chief Engineer (Structures). If in the opinion of the Deputy Chief Engineer (Structures) the discrepancies have impaired the value of the test in progress the test shall be started again. No additional payment will be made for correcting the settlement-measuring system(s) nor for portions of any load test unacceptable to the Deputy Chief Engineer (Structures).

6. Load Readings

Load readings (in tons) shall be taken for both the pressure gage on the jack and the load cell, and shall be recorded in the appropriate columns of Form CM 380a.

Failure Criterion:

Failure load for an incremental static load test is defined as that load at which the load vs. gross settlement curve reaches a slope of 0.05 inches per ton of applied load.

IV. PROCEDURE FOR THE CONSTANT-RATE-OF-PENETRATION TEST

One or more constant-rate-of-penetration tests, as specified in the contract documents, shall be performed to determine the ultimate capacity of the pile. All provisions of Chapters I, II, IIIA1, and IIIA2 shall apply to this test method.

Test Procedure:

Load the pile to either failure or the limit of the reaction load (minimum 4 times design load). Apply the load so that the pile top experiences a constant rate of deflection with time. Loads may be applied by means of a mechanical loading system, approved by the Deputy Chief Engineer (Structures), which will cause a constant rate of deflection with time. The rate of pile deflection, η in inches per minute is determined by the following relationship:

$$\eta = \lambda \frac{PL}{AE} \text{ inches per minute}$$

where λ = a soil constant (0.1 for cohesionless soils, 0.04 for cohesive soils, or a specified by the Deputy Chief Engineer (Structures)),

P = Maximum design load of the pile, kips, (as shown on the plans),

L = Length of the pile, inches,

A = Area of the pile, square inches, and

E = Modulus of elasticity of the pile, kips per square inch.

Control the rate of penetration by monitoring one dial gage at 15-second intervals. Record readings from all dial gages and the pressure gage for the jack and load cell at 1-minute intervals, on the time-settlement data sheet (Form SM 380a). At some point in the test, a minimal increase in load will maintain the settlement rate. This point indicates that failure of the pile-soil system is imminent. Once failure occurs, continue to test at the same deflection rate η for 15 minutes, after which this rate is to be increased to 5η inches per minute for another 5 minutes.

After completing this procedure remove the load in increments of 25 percent of the final load achieved. Maintain the rebound loads for 1 minute. Read all dial gages and record readings immediately before removing the next load increment. Measure the final rebound of the pile after all load has been removed for a period of 1 hour.

Settlement Reference Points:

Take readings at the settlement reference points at the beginning and end of test. Another test may be required if unexplained discrepancies occur as described in the preceeding chapter under "Settlement Reference Points."

Failure Criterion:

Failure load for this test shall be that at which the pile penetrates the ground with a minimal increase in load.

V. REPORTS AND CERTIFICATION

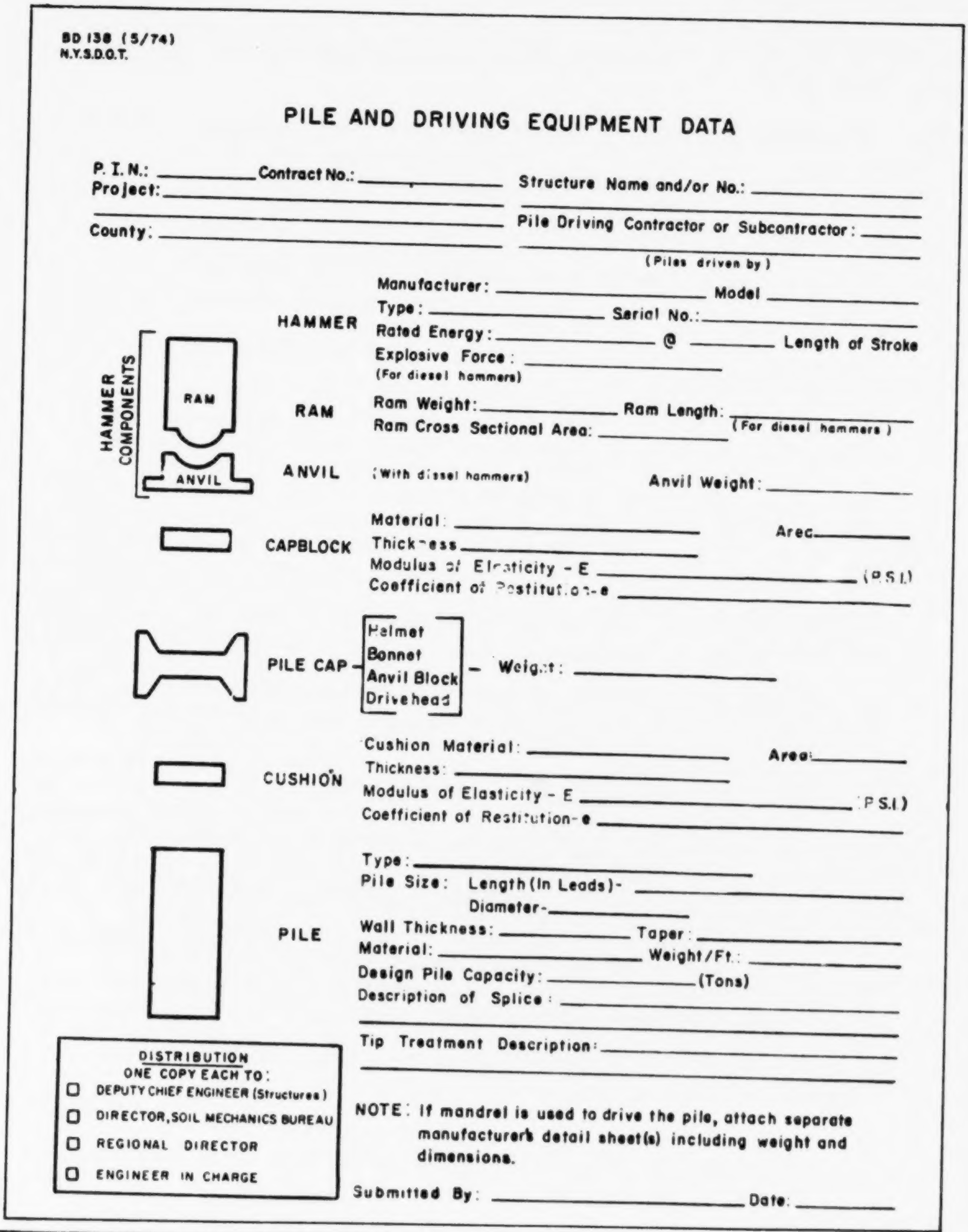
The following documentation is required for pile load tests:

1. A pre-driving report,
2. A post-driving report,
3. Certification of the loading device, and
4. A final report.

Pre-Driving Report:

Before the contractor receives permission to drive the test pile, he shall submit a report to the Deputy Chief Engineer (Structures) who will require five working days for review. The test pile shall be driven only after the Deputy Chief Engineer (Structures) has approved the details of this report in writing. The pre-driving report shall include the following information:

1. A description of the driving equipment (Fig. 6), including:
    a. Hammer type, make and model, and serial number,
    b. Capblock and cushion dimensions and material, including modulus of elasticity and coefficient of restitution,
    c. Data pertaining to any other applicable appurtenances,
    d. The steam, air, or hydraulic pressure to be applied to the hammer,
    e. The hammer's rated energy, rate of operation, and length of stroke, and
    f. A description of the test pile, including its type, the pile material, wall thickness, tip and top details, and the diameter and length to be placed in the leads.
2. A description of the method of testing, including the following:
    a. Type and amount of dead-load reaction, or size and description of reaction frame and location of reaction piles,



BD 138 (5/74)
N.Y.S.D.O.T.

PILE AND DRIVING EQUIPMENT DATA

P. I. N.: ________ Contract No.: ________ Structure Name and/or No.: ________
Project: ________
County: ________ Pile Driving Contractor or Subcontractor: ________
(Piles driven by)

HAMMER COMPONENTS

HAMMER
Manufacturer: ________ Model ________
Type: ________ Serial No.: ________
Rated Energy: ________ @ ________ Length of Stroke
Explosive Force: ________
(For diesel hammers)

RAM
Ram Weight: ________ Ram Length: ________
Ram Cross Sectional Area: ________ (For diesel hammers)

ANVIL
(With diesel hammers) Anvil Weight: ________

CAPBLOCK
Material: ________ Area ________
Thickness ________
Modulus of Elasticity - E ________ (P.S.I.)
Coefficient of Restitution-e ________

PILE CAP - Helmet / Bonnet / Anvil Block / Drivehead - Weight: ________

CUSHION
Cushion Material: ________ Area: ________
Thickness: ________
Modulus of Elasticity - E ________ (P.S.I.)
Coefficient of Restitution-e ________

PILE
Type: ________
Pile Size: Length (In Leads)- ________
Diameter- ________
Wall Thickness: ________ Taper: ________
Material: ________ Weight/Ft.: ________
Design Pile Capacity: ________ (Tons)
Description of Splice: ________
Tip Treatment Description: ________

DISTRIBUTION
ONE COPY EACH TO:
- ☐ DEPUTY CHIEF ENGINEER (Structures)
- ☐ DIRECTOR, SOIL MECHANICS BUREAU
- ☐ REGIONAL DIRECTOR
- ☐ ENGINEER IN CHARGE

NOTE: If mandrel is used to drive the pile, attach separate manufacturer's detail sheet(s) including weight and dimensions.

Submitted By: ________ Date: ________

Figure 6. Form for description of pile and driving equipment.

b. Method of supporting reference beam and measuring devices, showing distances from the test pile and anchor piles, or the supports for a reaction and its height above ground,

c. Capacity of pressure gages and hydraulic jacks.

Post-Driving Report:

The post-driving report shall include five items to be transmitted to the Engineer-in-Charge and included in the final report. The Engineer-in-Charge will also transmit this information by telephone to the Deputy Chief Engineer (Structures) before beginning the pile load test:

1. The test pile driving or re-driving records, including blows per foot throughout the length driven and final driving resistance in blows per inch for the last 18 inches,
2. Actual rate of hammer operation during test pile driving,
3. Embedded length of pile,
4. Length of pile tested, and
5. Methods employed by the contractor to prevent pile rebound immediately after driving.

Certification of Loading Devices:

The contractor shall calibrate the hydraulic system, jack(s), and pressure gage(s) within 14 days of starting the test. Calibration includes readings for loading and unloading. Loading system accuracy shall be within 5 percent of the load applied. The contractor shall submit calibration data to the Deputy Chief Engineer (Structures) before any load testing, and include a copy of the jack certification and load calibration curve in the final report.

No recalibration of the above elements will be required for more than one load test on the same project providing the following conditions are satisfied:

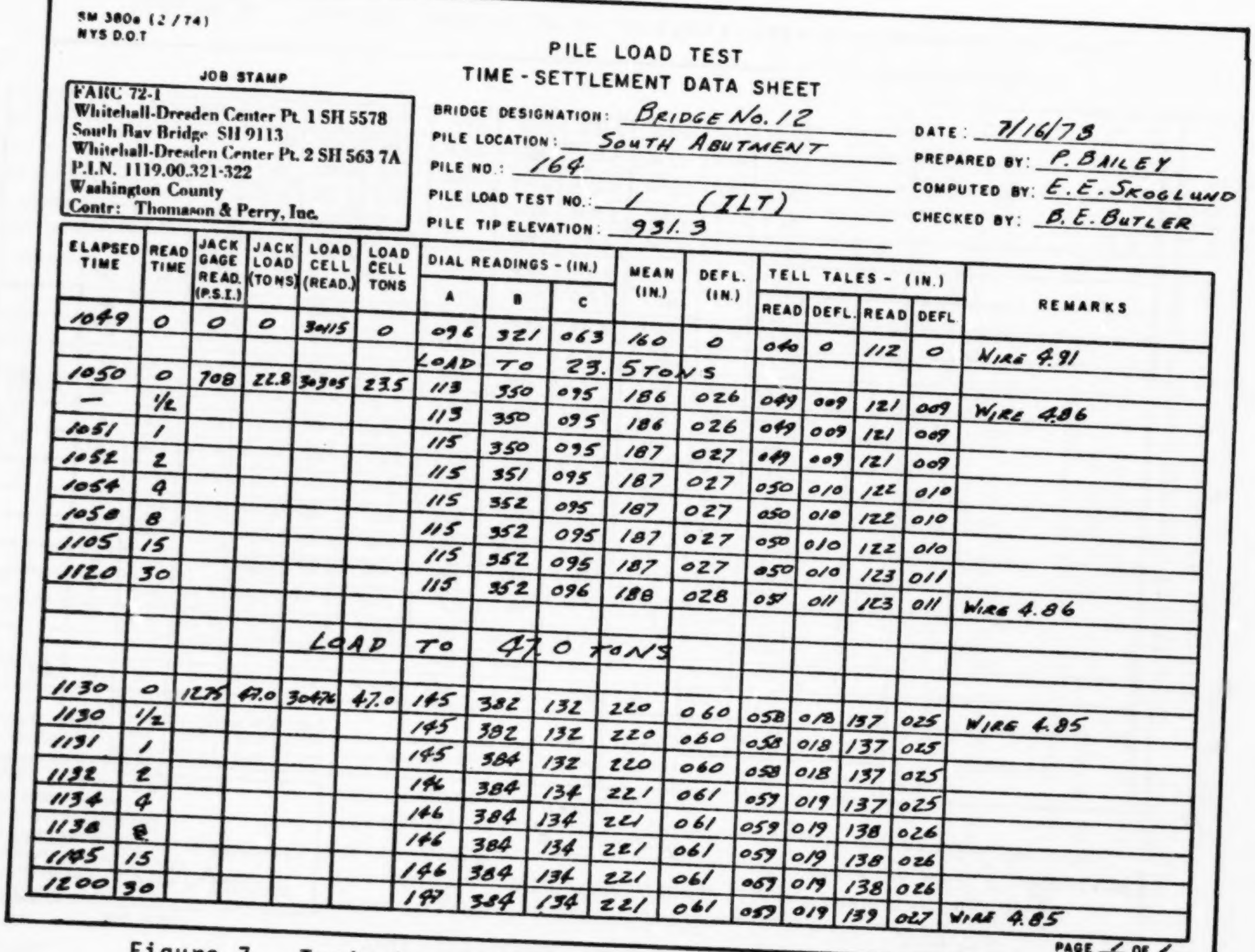
1. The equipment which has been calibrated and approved is not removed from the project for use elsewhere until all load tests are completed,

2. The calibrated equipment is carefully stored and properly maintained between tests in a manner approved by the Engineer-in-Charge,
3. The calibrated equipment is not subjected to abuse of any kind while maintained for use on a specific project,
4. The time period between load tests using the approved calibrated equipment on the same project does not exceed 1 month, and
5. Readout results are ascertained to be within the required accuracy criteria.

Final Report:

A final report shall be prepared by the contractor for each load test and shall contain the following information:

1. Identification of the test pile,
2. Description of the test apparatus and the loading and deflection measurement procedure used,
3. A copy of the time-settlement data collection sheets exactly as filled out in the field (Figs. 7 and 8), (re-copied or typed sheets will not be acceptable),
4. A graphic representation of test results in the form of load-settlement curves (Figs. 9 and 10), including gross and net settlement of top and telltales. Load-settlement vs. time curves (Fig. 11) should be included so that elastic properties of the supporting soils may be determined,
5. Remarks concerning any unusual events or damage to the pile during driving or load testing,
6. Miscellaneous data, including;
   a. Structure for which piles are to be driven,
   b. Maximum pile design load shown on the plans,
   c. Date pile was driven,
   d. A copy of the pile-driving record,
   e. Dates of pile testing,
   f. A copy of Form BR 300a, if required (Fig. 5),



SM 380e (2/74)
NYS D.O.T

PILE LOAD TEST
TIME - SETTLEMENT DATA SHEET

JOB STAMP

FARC 72-1
Whitehall-Dresden Center Pt. 1 SH 5578
South Bay Bridge SH 9113
Whitehall-Dresden Center Pt. 2 SH 563 7A
P.I.N. 1119.00.321-322
Washington County
Contr: Thomason & Perry, Inc.

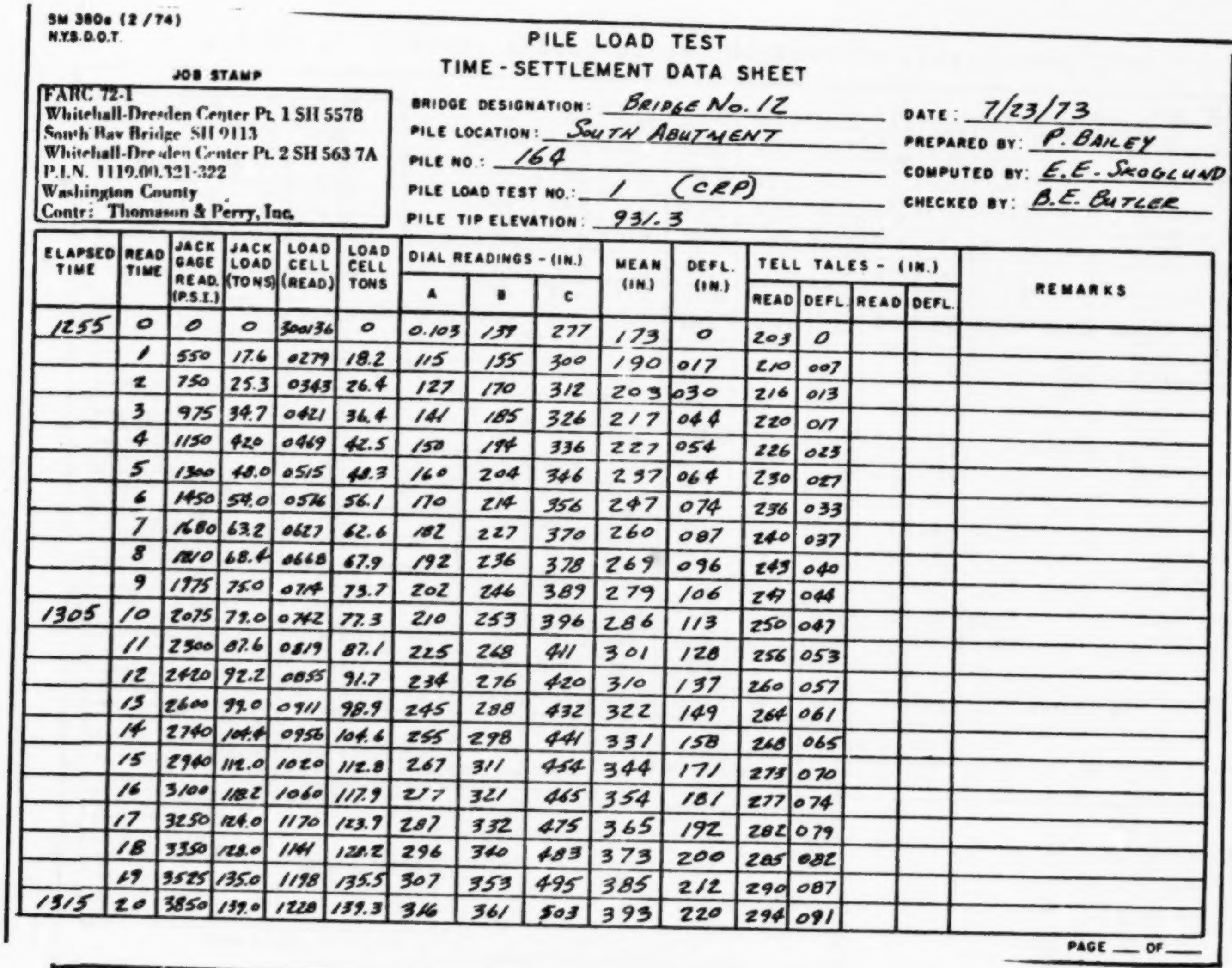
BRIDGE DESIGNATION: BRIDGE No. 12
PILE LOCATION: SOUTH ABUTMENT
PILE NO.: 164
PILE LOAD TEST NO.: 1 (ILT)
PILE TIP ELEVATION: 931.3

DATE: 7/16/73
PREPARED BY: P. BAILEY
COMPUTED BY: E. E. SKOGLUND
CHECKED BY: B. E. BUTLER

ELAPSED TIME	READ TIME	JACK GAGE READ. (P.S.I.)	JACK LOAD (TONS)	LOAD CELL (READ.)	LOAD CELL TONS	DIAL READINGS - (IN.)			MEAN (IN.)	DEFL. (IN.)	TELL TALES - (IN.)				REMARKS
						A	B	C			READ	DEFL.	READ	DEFL.	
1049	0	0	0	30115	0	096	321	063	160	0	040	0	112	0	WIRE 4.91
						LOAD TO 23.5 TONS									
1050	0	708	22.8	30305	23.5	113	350	095	186	026	049	009	121	009	WIRE 4.86
—	½					113	350	095	186	026	049	009	121	009	
1051	1					115	350	095	187	027	049	009	121	009	
1052	2					115	351	095	187	027	050	010	122	010	
1054	4					115	352	095	187	027	050	010	122	010	
1058	8					115	352	095	187	027	050	010	122	010	
1105	15					115	352	095	187	027	050	010	123	011	
1120	30					115	352	096	188	028	051	011	123	011	WIRE 4.86
				LOAD TO 47.0 TONS											
1130	0	1275	47.0	30476	47.0	145	382	132	220	060	058	018	137	025	WIRE 4.85
1130	½					145	382	132	220	060	058	018	137	025	
1131	1					145	384	132	220	060	058	018	137	025	
1132	2					146	384	134	221	061	059	019	137	025	
1134	4					146	384	134	221	061	059	019	138	026	
1138	8					146	384	134	221	061	059	019	138	026	
1145	15					146	384	134	221	061	059	019	138	026	
1200	30					147	384	134	221	061	059	019	139	027	WIRE 4.85

PAGE 1 OF 1

Figure 7. Typical report on an incremental-static-load test.



SM 380a (2/74)
N.Y.S.D.O.T.

JOB STAMP

FARC 72-1
Whitehall-Dresden Center Pt. 1 SH 5578
South Bay Bridge SH 9113
Whitehall-Dresden Center Pt. 2 SH 563 7A
P.I.N. 1119.00.321-322
Washington County
Contr: Thomason & Perry, Inc.

PILE LOAD TEST
TIME - SETTLEMENT DATA SHEET

BRIDGE DESIGNATION: BRIDGE No. 12
PILE LOCATION: SOUTH ABUTMENT
PILE NO.: 164
PILE LOAD TEST NO.: 1 (CRP)
PILE TIP ELEVATION: 931.3

DATE: 7/23/73
PREPARED BY: P. BAILEY
COMPUTED BY: E.E. SKOGLUND
CHECKED BY: B.E. BUTLER

ELAPSED TIME	READ TIME	JACK GAGE READ. (P.S.I.)	JACK LOAD (TONS)	LOAD CELL (READ)	LOAD CELL TONS	DIAL READINGS - (IN.)			MEAN (IN.)	DEFL. (IN.)	TELL TALES - (IN.)				REMARKS
						A	B	C			READ	DEFL.	READ	DEFL.	
1255	0	0	0	300136	0	0.103	159	277	173	0	203	0			
	1	550	17.6	0279	18.2	115	155	300	190	017	210	007			
	2	750	25.3	0343	26.4	127	170	312	203	030	216	013			
	3	975	34.7	0421	36.4	141	185	326	217	044	220	017			
	4	1150	420	0469	42.5	150	194	336	227	054	226	023			
	5	1300	48.0	0515	48.3	160	204	346	237	064	230	027			
	6	1450	54.0	0576	56.1	170	214	356	247	074	236	033			
	7	1680	63.2	0627	62.6	182	227	370	260	087	240	037			
	8	1810	68.4	0668	67.9	192	236	378	269	096	243	040			
	9	1975	75.0	0714	73.7	202	246	389	279	106	247	044			
1305	10	2075	79.0	0742	77.3	210	253	396	286	113	250	047			
	11	2300	87.6	0819	87.1	225	268	411	301	128	256	053			
	12	2420	92.2	0855	91.7	234	276	420	310	137	260	057			
	13	2600	99.0	0911	98.9	245	288	432	322	149	264	061			
	14	2740	104.4	0956	104.6	255	298	441	331	158	268	065			
	15	2940	112.0	1020	112.8	267	311	454	344	171	273	070			
	16	3100	118.2	1060	117.9	277	321	465	354	181	277	074			
	17	3250	124.0	1170	123.9	287	332	475	365	192	282	079			
	18	3350	128.0	1141	128.2	296	340	483	373	200	285	082			
	19	3525	135.0	1198	135.5	307	353	495	385	212	290	087			
1315	20	3850	139.0	1228	139.3	316	361	503	393	220	294	091			

PAGE ___ OF ___

Figure 8. Typical report on a constant-rate-of-penetration test.

g. Report on calibration of jack(s) and gage(s),
h. A plot of jack calibration results,
i. Elevation of groundwater during test, if possible.
j. Description of soil, based on the boring log of the nearest drill hole, and
k. Records of level readings, taken as described previously in connection with settlement reference points.

Upon completion, six copies of this final report shall be forwarded directly to the Deputy Chief Engineer (Structures) for analysis. Upon receipt, five working days will be required for review, after which the Deputy Chief Engineer (Structures) will forward his findings to the Regional Director. If the static load test results in a failure (as defined in Chapter III) at a load less than 2 times the design load, a final report is still required, in that event the Deputy Chief Engineer (Structures) may order an additional static test.

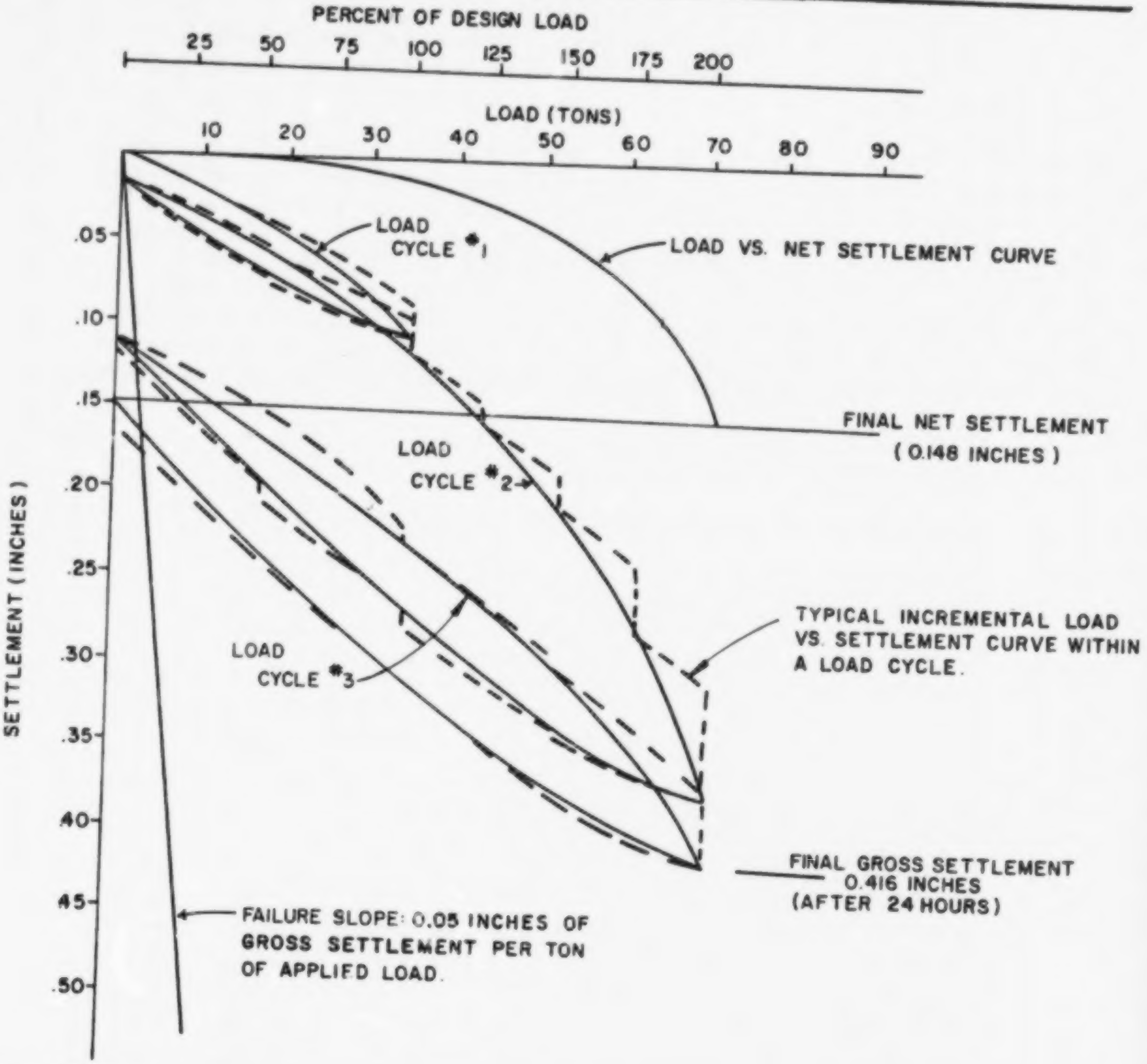
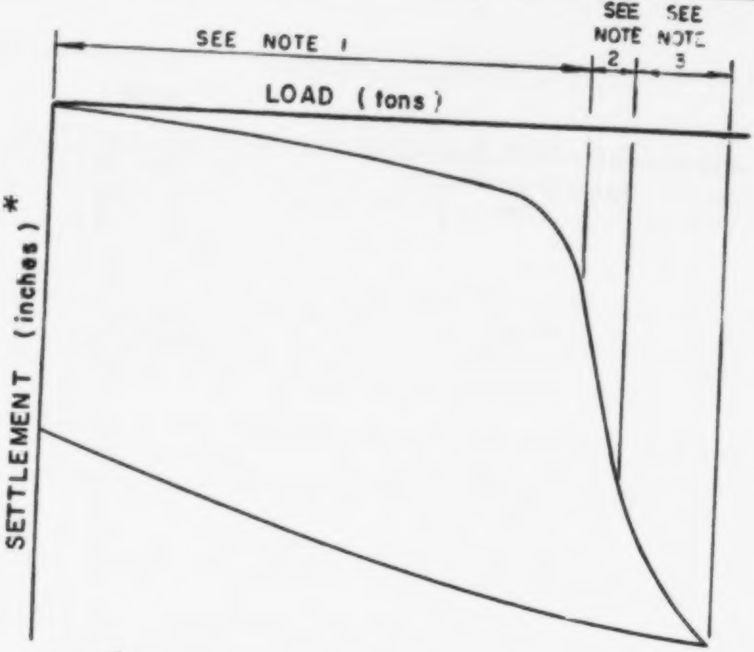


Figure 9. Load-settlement curves for a typical incremental-static-load test.



*DETERMINED FROM AVERAGE OF BUTT DEFLECTION DIALS

Notes:

1. The rate of pile deflection η may be determined by the following relationship:

$$\eta = \lambda \frac{PL}{AE} \text{ inches per minute}$$

where λ = a soil constant [0.1 for cohesionless soils, 0.04 for cohesive soils, or as specified by the Deputy Chief Engineer (Structures)],

P = maximum design load of the pile, kips (as shown on the plans),

L = length of the pile, inches,

A = area of the pile, square inches, and

E = modulus of elasticity of the pile, kips per square inch.

2. Maintain the rate of pile penetration η for 15 minutes in this zone.

3. **The rate of pile penetration is to be 5η, in this zone, maintained for 5 minutes.**

Figure 10. Load-settlement curve for a typical constant-rate-of-penetration test.

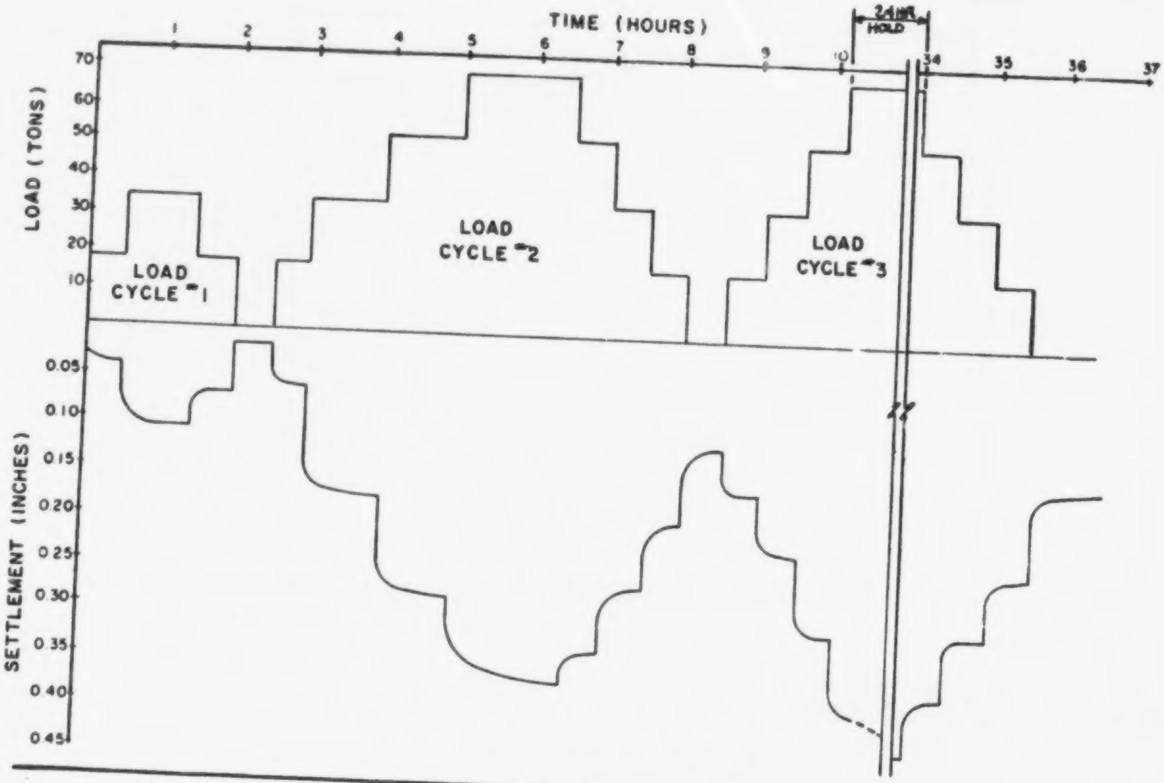


Figure 11. Load-settlement vs. time for an incremental-static-load test with a design load of 35 tons (typical for all design loads).

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A SUMMARY OF THE USE OF SAWDUST FOR HIGHWAY FILLS

By

N. C. Jackson
Pavement Design Engineer
Washington State Department of Transportation

Introduction

In the coastal area of southwest Washington, both climate and geology combine to produce a region with a high incidence of existing landslides and, with any change in land form, a high potential for new landslides. In general the geologic units found in this area are not all that unusual. They range in age from Eocene to Recent, with the oldest being the Crescent formation, a series of basaltic rocks, and the youngest the recent alluvium and tidal mud commonly found in the lowlying river mouths. The great preponderance of landslides occurs in only one of the various formations comprising this very thick series of rocks. Somewhere near the middle of the stratigraphic column is a formation known as the Astoria.

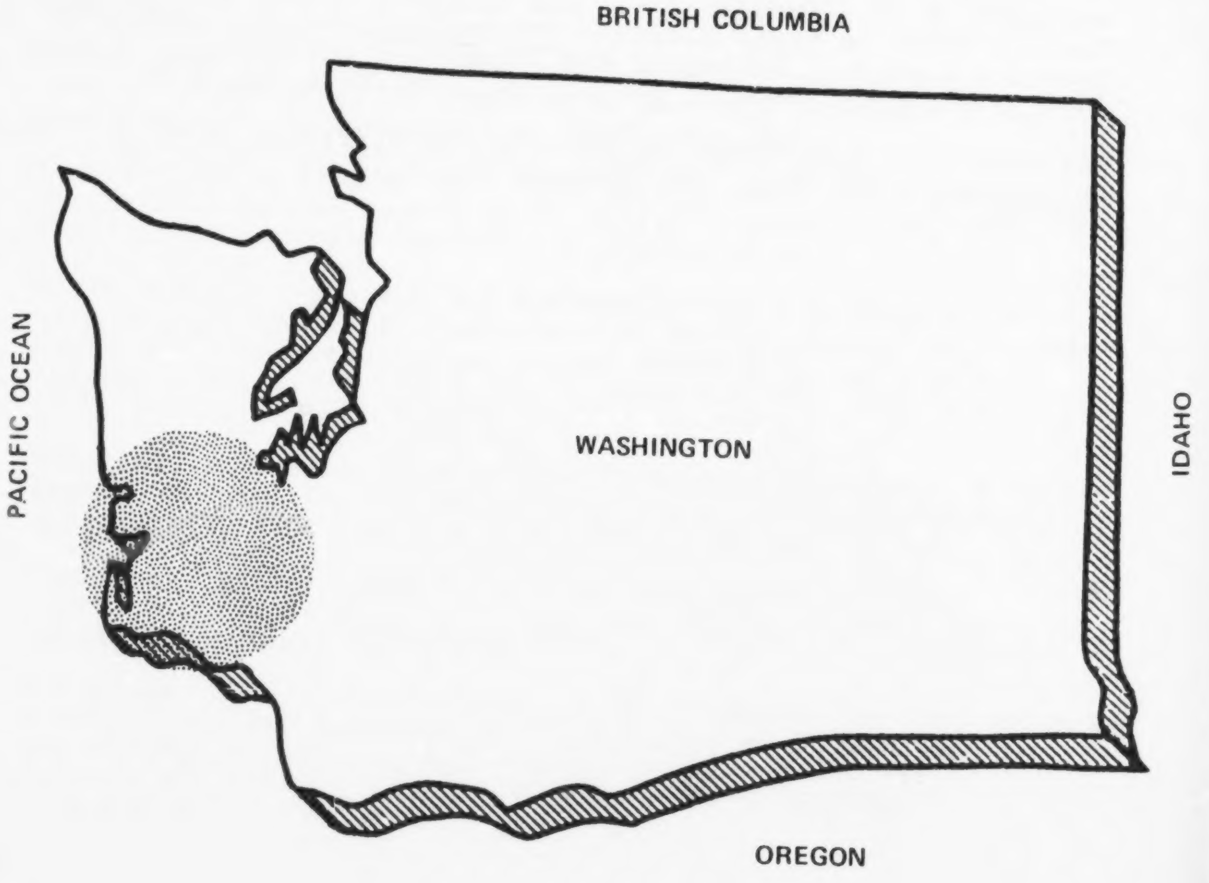

Figure 1 - Vicinity Map

The Astoria varies from claystone to conglomerate, with an intraformational basalt. It is most easily differentiated from the underlying Lincoln Creek formation by the abundance of mica and carbonaceous material, lack of tuffaceous material, and better bedding. It differs from the overlying Montesano formation in that the sandstone beds are usually fine-grained and silty, and the conglomerate poorly sorted. The siltstone units contain considerable amounts of clay minerals and are, therefore, much less competent in outcrop than the Montesano.

The inordinate number of landslides in this formation is probably due to the high percentage of both mica and clay minerals. Bedding may have an influence in some areas, but in the majority of cases the mineralogy of the material combined with high moisture to cause sliding. The heavy rainfall, which often exceeds 100 inches per year, in addition to producing high ground moisture, has produced deep and intensive weathering, resulting in greater instability.

The early economy of this region was primarily timber-oriented. Early roadbuilders routinely used wood products as construction materials. Many of today's roads still overlay original corduroy roads. These are roads that were built over logs or planks, usually placed crosswise to the direction of travel. Sawdust fills are quite common in the region. Many of the logging towns, located next to rivers or saltwater, were built on sawdust fills placed over mud or tide flats. With this heritage, it is not surprising that there has been, for some time, many proponents who have recognized the potential of using wood-waste products to help solve our most perplexing stability problems in the region.

Our first documented use of sawdust began in March of 1972 when a slide took out a section of SR 101 several miles south of the town of Cosmopolis. Unfortunately, this is an all too common occurrence on this section of highway, which is a major commercial route for the area's timber industry. To reestablish the route, the local maintenance division chose to use wood-waste products readily available in Cosmopolis to reconstruct the roadway. The material was chosen because its light weight would reduce the driving force on the old slide mass, and because its strength is relatively unchanged by major changes in moisture content, thus allowing it to be used in very wet weather. In a region where many attempts at slide correction or stabilization have been only marginally successful, this "emergency work" seemed to do the job.

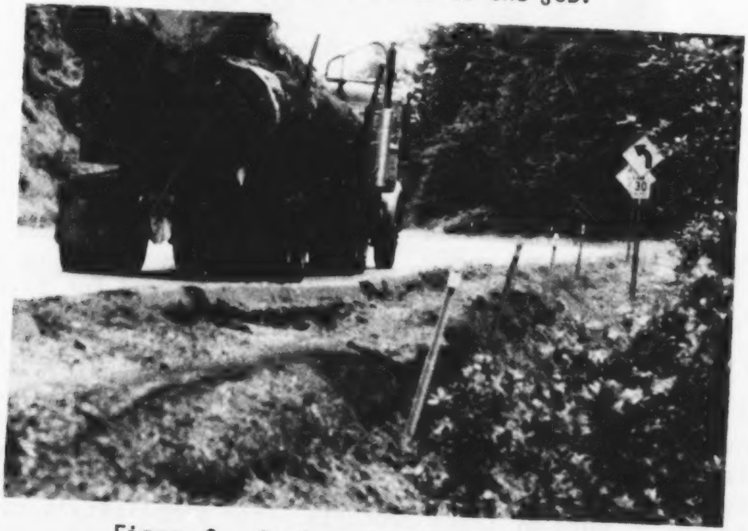

Figure 2 - Sawdust Fill - 6 years old

The success of this project prompted the use of sawdust a year later on another slow-moving slide within a mile of the first project. This section had required constant effort to maintain adequate geometry and presented the ever present threat of major movement which might again close the highway. The top 10 feet of the existing roadway, through the area of the slide, was removed and replaced with sawdust. As is common practice in most slide corrections, internal and diversionary drainage was also installed. Both projects appear to have been successful in stopping all slide movement to date.

Details concerning both projects are covered in a Status Report published by the Federal Highway Administration in 1974, authored by David Nelson and Bill Allen. A film which shows the sawdust embankment construction was also made of the latter project and is available through the Federal Highway Administration.

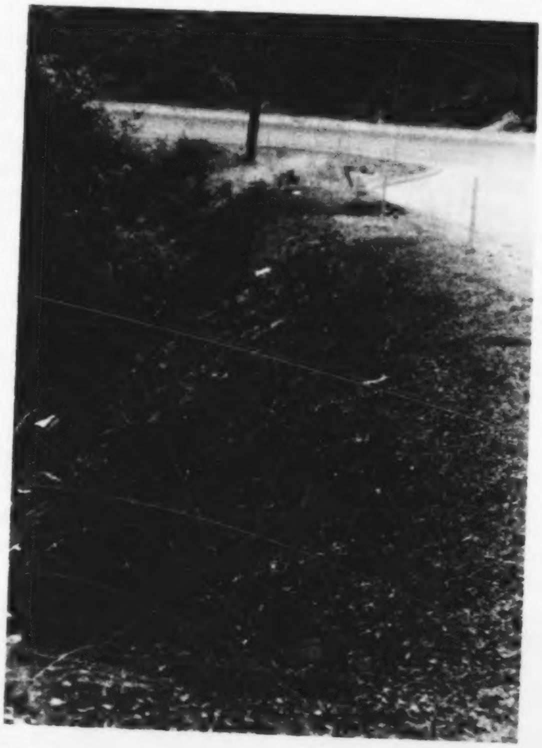

Figure 3 - Sawdust Fill - crack typical on fills with steep side slope

In the intervening years we have used wood-waste products in an additional nine projects. On most of these projects sawdust was used for slide correction or reconstruction. It has, however, also been used on a few projects as a lightweight fill material to construct embankments over very soft foundation soils, generally consisting of peat and/or organic silts and clays. Considering the number of separate installations where sawdust was used, a discussion of each is not warranted. Instead, our general application of sawdust will be discussed using a couple of typical projects as examples. The wood-waste product used on these projects has been either sawdust, hog fuel, planer or bark chips, or a combination of one or more of these products. For simplicity's sake, I will not try to differentiate between these products, but will refer to them simply as sawdust.

Landslide Reconstruction or Stabilization

As you might expect, the reconstruction of a missing section of the roadway prism, varying from a short section of shoulder to a portion of the roadway, accounts for the greatest number of installations but the least quantity of sawdust. These projects typically have been put together by the Project Engineer in the field, either as an individual project or as part of a larger pavement rehabilitation project. Each installation has been quite simple. Typically, the old slide mass is dressed up, internal and diversionary drainage is installed if possible, and the missing section of roadway is reconstructed using sawdust. This use has been simple and successful. Though some of the sections have experienced minor consolidation of the sawdust, there has been no renewed movement of the original slide.

On several specific projects, sawdust was used in an attempt to stabilize an active slow-moving landslide. In most of these sections, continued patching by Maintenance personnel to provide a passable grade had actually resulted in total pavement depths ranging from four to eight feet. Sections thus maintained have become quite narrow and have most unusual horizontal and vertical geometry. One must recognize that the risk of total failure increases as the driving force is slowly increased on the slide mass.

Rock Crusher Slide repair on SR 101, between Raymond and Aberdeen, is typical of this type of project. This is one of many sections on this route where the roadway apparently crossed over an existing landslide. There have been several attempts at stabilizing the slide through various drainage strategies since at least some time in the 1940's.

In 1975, a soils investigation was begun to determine means of stabilizing the slide. Five test holes were drilled to depths of 70 ft in the slide block, with inclinometer casing installed in each. The test holes encountered 35 ft to 50 ft of soft to stiff clay-sands and silts overlying very stiff silts and clays layered with soft shales. Although there were several active slide planes, the major plane appeared to be in the deeper clays, silts, and soft shales. Our analysis indicated that we could gain a 20 to 30 percent increase in stability

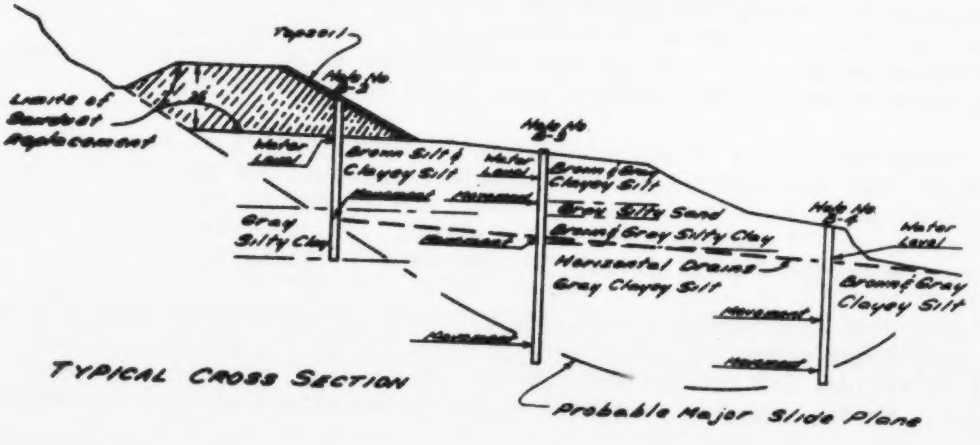
SR 101 - ROCK CRUSHER HILL SLIDE
Topsoil
Limits of Sawdust Replacement
Hole No B-2
Water Level
Brown Silt & Clayey Silt
Movement
Gray Silty Clay
Hole No B-3
Water Level
Brown & Gray Clayey Silt
Movement
Gray Silty Sand
Brown & Gray Silty Clay
Movement
Horizontal Drains
Gray Clayey Silt
Movement
Hole No B-4
Water Level
Brown & Gray Clayey Silt
Movement
Movement
TYPICAL CROSS SECTION
Probable Major Slide Plane

Figure 4 - Cross Section - Rock Crusher Hill Slide

by lowering the water level in the slide mass 15 to 30 feet. This could then be improved an additional 10 percent by replacing the top 15 ft of embankment with sawdust, or 20 percent by replacing the top 25 ft with sawdust. As there was some question concerning the extent of the slide mass, we chose to use both drainage and sawdust in the correction. A buttress was considered but rejected because it was much more efficient and cheaper to reduce the driving force than try to counterbalance it.

The project was constructed in the summer and fall of 1978. There has since been no sign of renewed slide movement. It has, however, experienced some significant consolidation of the sawdust, resulting in the surfacing dropping uniformly six to eight inches within the limits of the sawdust replacement. It is interesting to note that the guardrail placed some time after surfacing shows only minor change in grade.

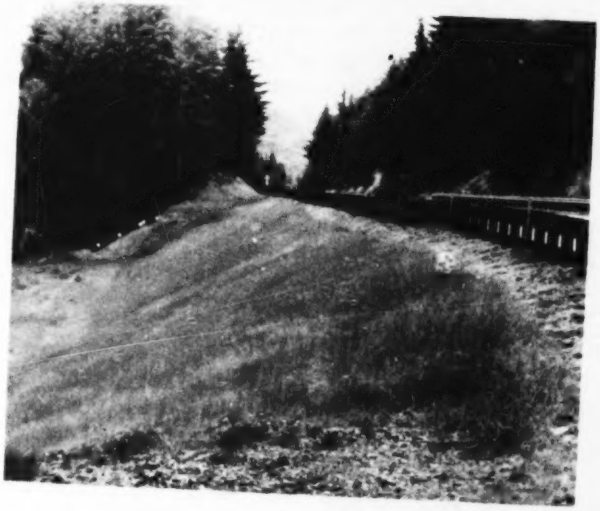

Figure 5 - Sawdust Fill - Rock Crusher Hill Slide

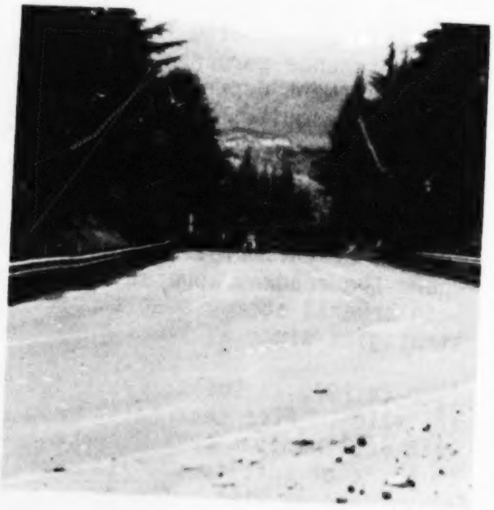

Figure 6 - Dip defines limits of sawdust replacement

In general, we have experienced the greatest consolidation at the ends of the sawdust fill where the compactive effort is least, most of it occurring quite rapidly after completion of the surfacing. Some areas have required minor maintenance patching. As we have anticipated added long-term maintenance cost over more standard construction, this comes as no surprise.

To reduce the effect of post-construction consolidation of the sawdust, we recommend that the side slope contact between sawdust and natural ground be as flat as possible. The amount of consolidation may be reduced by placing a small surcharge, if construction timing allows. If not, the surface of the roadway may be cambered in proportion to the depth of sawdust.

We have also experienced some slope distress on the outside edge of the sawdust embankment where the sides were constructed to 1:1 slopes. As the distress is minimal and not yet endangering the roadway, we have not taken any action. We do, however, recommend maximum side slopes of 1½:1 in sawdust.

Other than the few problems noted, all of the slide corrections have been successful. There are, at present, no signs of renewed movement in any of the old slide masses. Considering past successes in these endeavors in this region, we are quite satisfied with the results.

We have, on several projects, used sawdust to construct either a new embankment, or to widen existing embankments over deep deposits of very soft peat and/or organic silts and clays. Typical of this type of project was a 100,000 CY sawdust embankment constructed as part of a grading and surfacing project on SR 101 between South Bend and Raymond. Here, the alignment crossed a 600-ft-long section of tidal flats before tying back into the existing alignment. Test holes indicated that the soils consisted of 20 to 70 ft of very soft peat, together with organic silts and clays overlying steeply dipping sandstone. Standard penetrometer blow counts of less than one were encountered to a depth of 25 to 30 ft.

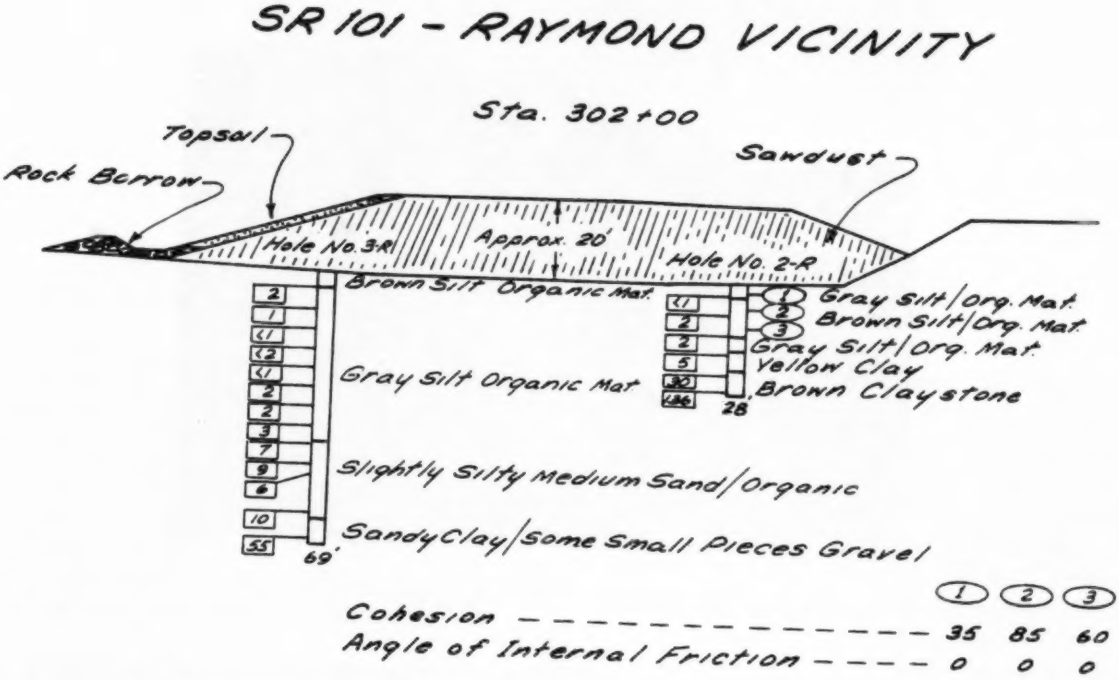
SR 101 - RAYMOND VICINITY
Sta. 302+00
Topsoil
Rock Borrow
Sawdust
Hole No. 3-R
Approx. 20'
Hole No. 2-R
Brown Silt Organic Mat.
Gray Silt Organic Mat
Slightly Silty Medium Sand/Organic
Sandy Clay/Some Small Pieces Gravel
2
1
<1
<2
<1
2
2
3
7
9
6
10
55
69'
① Gray Silt/Org. Mat.
② Brown Silt/Org. Mat.
③
Gray Silt/Org. Mat.
Yellow Clay
Brown Claystone
<1
2
2
5
30
136
28'
① ② ③
Cohesion - - - - - - - - - - - - - - - 35 85 60
Angle of Internal Friction - - - - 0 0 0

Figure 7 - Raymond Sawdust Fill

To construct a reasonably stable embankment, our original design called for removal of the very soft foundation soil to a depth of 20 to 25 ft to be replaced with quarry rock. Even with the partial removal of the very soft foundation soils, our analysis indicated that we could anticipate total embankment subsidence of over 3 ft, occurring rather slowly. Thus, a surcharge was also called for.

With fairly recent success of the first two sawdust installations 20 miles north of this location, an alternate design using sawdust was considered. It was determined that a stable sawdust embankment could be constructed without removal of the underlying foundation soils. It was also determined that with the markedly reduced settlements a surcharge was not warranted. The original comparative estimate made in 1973 indicated approximately $250,000 savings by using sawdust. Considering the saving in money and time, this option was selected. By today's costs, the difference could easily be over $500,000.

The sawdust embankment was constructed during the summer of 1976. It was topped off with ballast and served as a detour through the following winter, and was finally paved in the spring of 1977.

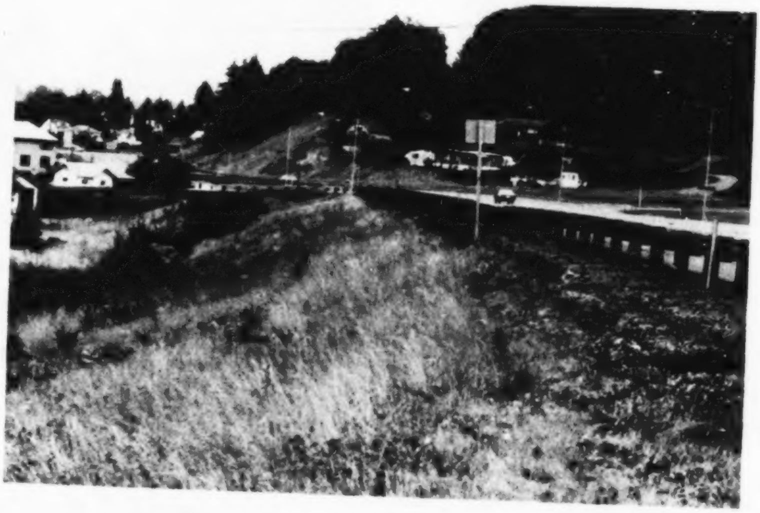

Figure 8 - Sawdust Fill - Raymond Vicinity

With a few exceptions, the performance of the embankment has been about as expected. We experienced somewhat more consolidation of the sawdust than expected, considering the lengthy construction period. Maintenance patching was required in one area where a trench was cut in the embankment to place a 12-inch water line crossing after completing the embankment. It was not possible to backfill the sawdust to the same density as the surrounding embankment, thus resulting in additional consolidation in the area of the trench after construction. It is interesting to note that this did not show up under the weight of partial surfacing and traffic during the winter, as one might expect it should.

Most of our in situ testing was performed on this embankment. The various tests and subsequent results will be discussed later in the report.

The remaining projects not discussed involved the widening of existing embankments over similar, very soft foundation soils. As with the first project, the difference in cost between using sawdust and other more standard construction techniques was significant on each project.

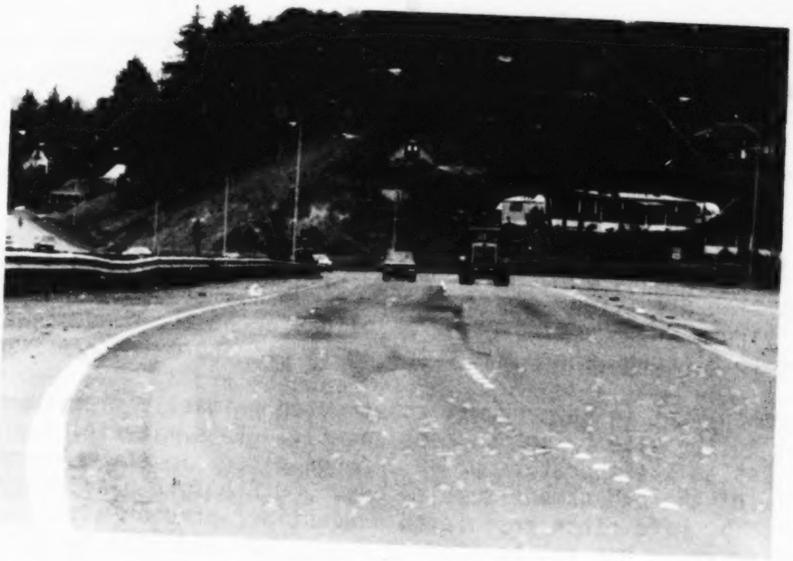

Figure 9 - Dip in guardrail and patching define culvert crossing in sawdust fill

In Situ Testing

Various in situ tests were performed on the sawdust embankment constructed in Raymond. As you might expect, we found it most difficult to imitate field densities in the laboratory with repeatable results. Nelson and Allen[1/] determined that the angle of internal friction of the hog fuel they tested was 31°, using a triaxial test. Lea and Brawner[2/] reported an angle of internal friction of 50° for sawdust, determined by direct shear tests. We obtained a drained strength of 25° to 27°, with respective cohesions of 1300 psf and 300 psf from triaxial tests. We suspect the shape and orientation of the wood particles influenced the cohesion values.

The large sawdust embankment constructed in Raymond provided us the best opportunity we have had to test sawdust in place. Most sawdust fills are constructed and covered quickly, often within a period of days. This fill was available to us most of the summer and was covered only with topsoil and ballast through the winter.

Individual tests conducted on the sawdust consisted of in-place density, plate bearing, Dutch Cone penetration resistance, and seismograph. In addition, a settlement plate at the contact between sawdust and natural ground, roadway surface elevations, and the internal temperature of the sawdust were monitored for a period of a year after construction of the embankments.

Our data indicate that we achieved maximum in-place wet densities of 59 to 60 pcf. This was greater than anticipated; we are now using 60 pcf in our design. The Dutch Cone Penetrometer resistance indicates a maximum angle of internal friction ranging from 36° to 39°, increasing with depth. Allowing for some deterioration in strength with age, we are using 35° in design.

Data from the plate bearing tests, rebound deflection, and seismograph indicate that the surface of the sawdust is not nearly as strong as the original stabilometer test led us to believe. Our analysis of the data from these tests indicates that the sawdust embankment has a subgrade modulus E of 1400 psi in the top 1 to 2 ft. This equates roughly to a CBR of 1. We now require a minimum of two feet of surfacing over sawdust--more if the traffic warrants.

The settlement data indicated that we did experience somewhat more settlement than predicted. As the unit weight was also higher, this was not surprising. Post-construction consolidation of the sawdust was in the range of 6 to 8 inches where the total depth was approximately 20 ft.

The embankment in Raymond was constructed primarily from sawdust stockpiled next to the site by an adjacent sawmill. This material had started to decay and was at a temperature of +85°F when placed in the embankment. The temperature of the embankment rose to over 100°F before ultimately declining to ambient. We have since restricted sawdust accepted on a project to either fresh sawdust which has not started to decay, as evidenced by ambient or lower temperatures, or to very old sawdust which has stopped decaying, as evidenced by temperatures equal to or lower than ambient.

Discussion

My first recommendation to anyone considering the use of wood-waste products as an embankment material, as we have, is to approach it with a reasonable degree of caution. In spite of the number of installations just described, we have tried to limit the use of sawdust to specific applications where there is either a substantial economic advantage, or circumstances which limit normal construction techniques. Its use has also been limited to our coastal areas where there is both high rainfall (100 in. or greater) and moderate temperatures.

One must consider the risk of spontaneous heating and ignition of the sawdust. This does occur in loose sawdust piles, even in our coastal region. With the restricting of sawdust sources and the use of normal embankment construction techniques resulting in high densities, I think the risks are reasonable in our coastal region. In dryer, warm regions, or when used with minimal compaction control, the risks are probably quite great.

Associated with the construction of all sawdust fills is a potential water quality problem, due to an aqueous solution of wood extractives commonly known as leachate. It is evidenced by its dark color, oily sheen, foaming, and septic smell. It generally has a high metal ion content, high T.O.C. and B.O.D., low pH, and may be toxic in sufficient concentrations. It has been our experience that the oxygen demand and accompanying characteristics peak rather quickly and diminish rapidly with time. In general, the water draining from the sawdust is almost completely normal within six months to a year. It has also been our experience that the total quantity of flow is quite small. On projects where there has been a receiving stream in close proximity to the sawdust embankment, there was a very high dilution ratio between the leachate and the stream. Possibly the best treatment for leachate is by surface application to a highly forested area. We have not experienced any problems with leachate in these areas. Our major problems have occurred in urban areas. Again, the leachate is unsightly and has a foul odor.

For anyone considering the use of sawdust, I strongly urge you to read "A Study of Woodwaste Leachate"3/ by Schermer and Phipps, and "Consequences of Leaching from Pulp and Paper Mill Landfill Operations"4/ prepared by Econotech Services Limited of Canada.

Of final concern is the obvious lack of any definitive information concerning the life expectancy of a reasonably large sawdust embankment. Present popular predictions are for reasonable performance for at least 15 years. Inspection of much older sawdust piles in the area indicates that this may be quite conservative. I anticipate that we will experience progressive deterioration in the geometry of the roadway prism, increasing with time until some remedial reconstruction will be warranted. Thus, we will not be faced with total reconstruction of these projects in 15 years, but a need to perform some partial reconstruction at approximately that interval. This final question will only be answered with time.

Appended to this paper is Washington State Department of Transportation's present special provision for sawdust fill.

REFERENCES

1. D. S. Nelson and W. L. Allen, Jr., "Sawdust as Lightweight Fill Materials," Report No. FHWA-RD-74-502, May 1974 Status Report.
2. Norman D. Lea and C. O. Brawner, "Highway Design and Construction Over Peat Deposits in Lower British Columbia," N. D. Lea and Associates, Vancouver, B.C., and British Columbia Department of Highways, Victoria.
3. Eugene D. Schermer and James B. Phipps, "A Study of Woodwaste Leachate," Choker Research, Grays Harbor College, Aberdeen, Washington, Victoria.
4. Econotech Services Limited, "Consequences of Leaching from Pulp and Paper Mill Landfill Operations," CPAR Project Report 363-2, September, 1977, Ottawa, Ontario.

WASHINGTON DEPARTMENT OF TRANSPORTATION

SAWDUST FILL SPECIAL PROVISION

Lightweight Fill in Place

The sawdust borrow shall consist of 100 percent fresh wood fibers, such as sawdust, hog fuel or wood chips. Partially decomposed or decomposing wood fiber, as indicated by temperatures above ambient will not be allowed. The material shall be tested by the engineer and shall not have a temperature greater than 70 degrees Fahrenheit or greater than ambient temperature, whichever is higher. No composition wood products, such as particle or chip board, pressed hard-board, or presto-log fragments shall be used in this embankment. Maximum particle size will be 1 foot in the greatest dimension. Sufficient smaller sized material shall be used to produce a uniformly dense fill.

The lightweight fill may be constructed by end dumping of trucks or any other method approved by the engineer. Compaction shall be obtained by routing a D-7 or D-8 caterpillar type tractor, or equivalent, over the entire surface of each lift two times or to the satisfaction of the engineer. Placement and compaction shall be in layers not to exceed 1 foot of uncompacted depth. Compaction equipment shall weigh a minimum of 33,000 pounds.

During construction of the lightweight fill, the contractor shall cap the exposed lightweight fill slope as shown in the plans.

Lightweight fill shall be measured to near line dimensions in place.

The unit contract price per cubic yard for "Lightweight Fill in Place" shall be full compensation for furnishing all labor, materials, tools, and equipment necessary or incidental to furnishing, placing, and compacting the wood fiber, constructing the slope protection, and other work in accordance with the details shown on the plans, as described and as directed by the engineer.

PROJECT SUMMARY REPORT
ROCK SLOPE STABILIZATION
WASHINGTON STATE

SR 195
Paradise Road to Mullan Hill Road
MP 86.22 to MP 78.78

BY

R. H. Gietz
Special Projects Engineer
and
T. V. Zimmerman
Geologist

A major rock excavation was made on the NB lanes of this realignment project from MP 88.57 to MP 88.84. This cut exposed moderately massive basalt on the median side of the roadway with cuts up to 70 feet in depth. Core drilling at the location stage had disclosed an interbed area showing palagonite lenses up to a few feet thick below a significant depth of moderately massive basalt. The nature of this material was further confirmed by examination of the adjacent SB lanes separated by about 200 to 300 feet in this section. This combination gave a potential for substantial rockfall, possibly massive in nature, as a consequence of eventual weathering.

In order to minimize the potential traffic hazard, several features were incorporated at the planning stage:

1. A rockfall ditch was provided.
2. Presplitting rock cuts on a slope of ½ to 1 was specified.
3. A Force Account item for "rock slope stabilization" was set up with a special provision oriented toward the use of pneumatically applied mortar.

The contract for this project was awarded to N. A. Degerstrom, Inc., and construction began in June 1978 with rock excavation as a priority item of work in order to achieve the desired November 1978 completion. An initial test section of slope presplitting was made with 4-inch holes at a spacing of 2½ feet. Powder loadings were 1½-inches x 8-inches ½-lb sticks at 24- and 36-inch spacings. The lighter 36-inch spacing (.17-lb/ft) gave satisfactory presplitting, so this was used for the production presplitting. Production presplitting began in July and was performed in two lifts. Rock excavation was carried forward and the cut slopes fully formed about mid-August. The palagonite area was found to consist of a 6 to 8 foot deep matrix of palagonite with basalt inclusions, rather than a homogeneous layer of palagonite. No zones of groundwater were encountered in the slope.

Discussions were held on site with the contractor, and Project and District Construction personnel concerning preparation of slope areas and selection of areas to receive stabilization treatment. It was decided to use welded wire mesh anchored to the slope with spikes to reinforce the gunite layer. Additional preparation of the area to be treated was ordered to remove all weathered and loose material. This work was in addition to the normal scaling operation which had been completed.

Slope preparation began on October 4 with a 600-cfm compressor and blow pipe effectively used to displace the loose and weathered material. Approximately 2 to 4 inches of palagonite had weathered and cracked at this time. Following slope cleaning, 5 feet wide strips of 2 inch square welded wire fabric were anchored to the slope with 10 inch spikes. The fabric was 16 gage galvanized wire tied to the nails and spikes.

Gunite mix of 3/8 inch maximum aggregate with eight sacks of cement per yard was delivered to the project in transit mix trucks. It was placed on the slope using a concrete pump adapted for mounting a compressed-air placing nozzle. Placement depth was regulated to give about one inch cover to the mesh previously anchored to the slope. The placing technique used resulted in retention of virtually all mortar material on the slope. Waste was estimated at less than 5 percent. An overlay of 1 to 2 feet was made onto sound rock outside the palagonite zone. Following placement and prior to set, weep holes were made in the gunite zone by inserting a steel rod through the green mortar. No curing compound was applied, although a subsequent spray of water was made one day later as a partial curing measure.

The final gunite-treated area was measured as 836.12 square yards. The total Force Account cost for the stabilization work was $13,883.75, compared to the contract estimate amount of $25,000. The unit cost for all stabilization work was $16.61 per square yard. A total 0f 89 cu. yds. of mix were applied for an average computed yield depth of 3.8 inches.

Several unique features of this project contributed to the much lower cost than estimated. The use of spikes and nails instead of rock bolts, use of welded wire fabric instead of woven chain link type fence material, and the use of the metal rod to form weep holes instead of pipes through the gunite, all substantially reduced the cost of the project.

During construction the stabilization progressed rapidly and smoothly with few, if any, problems. It is our opinion that the use of gunite will prove to be a very effective method of controlling the often encountered zones of palagonite. Figures 1-8.

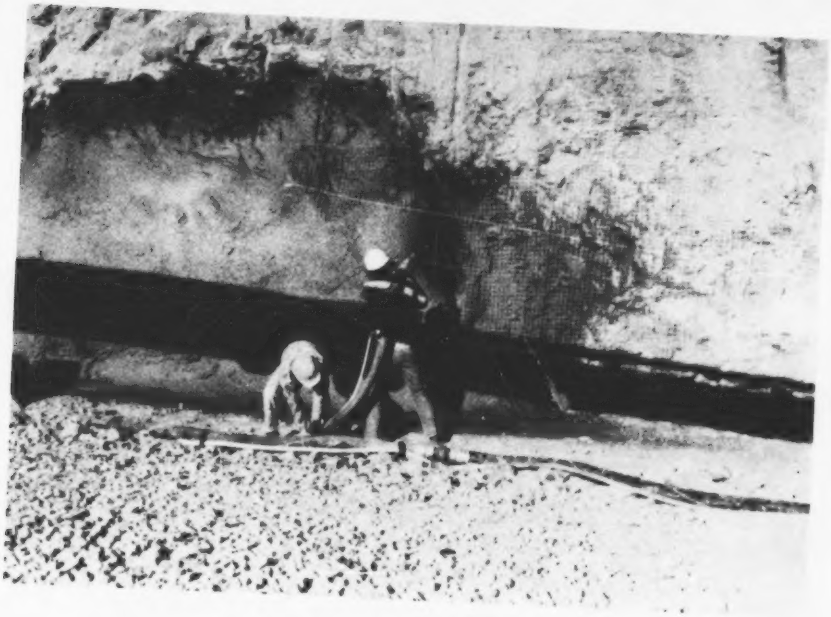

Fig. 1

Ground Application Nozzle must be nearly normal to the slope for best results. Note wire fabric on slope.

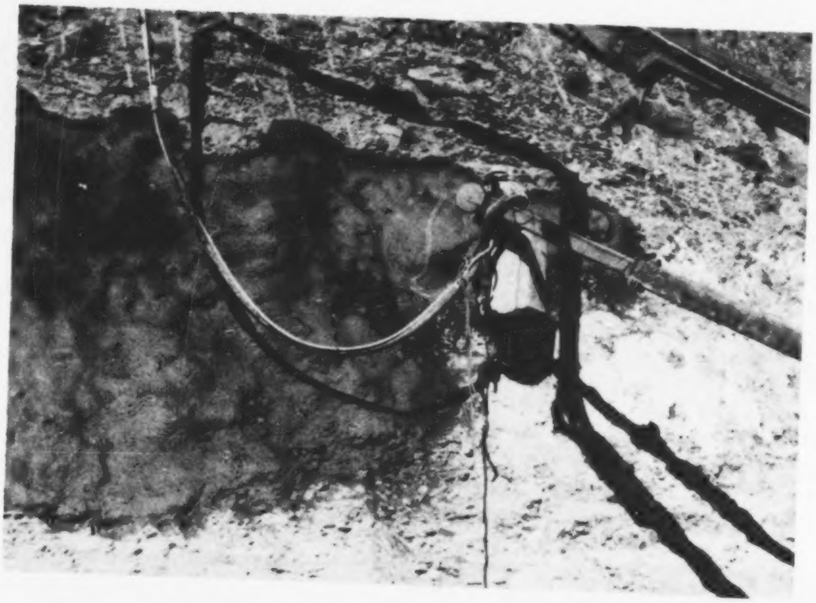

Fig. 2 - Aerial Application

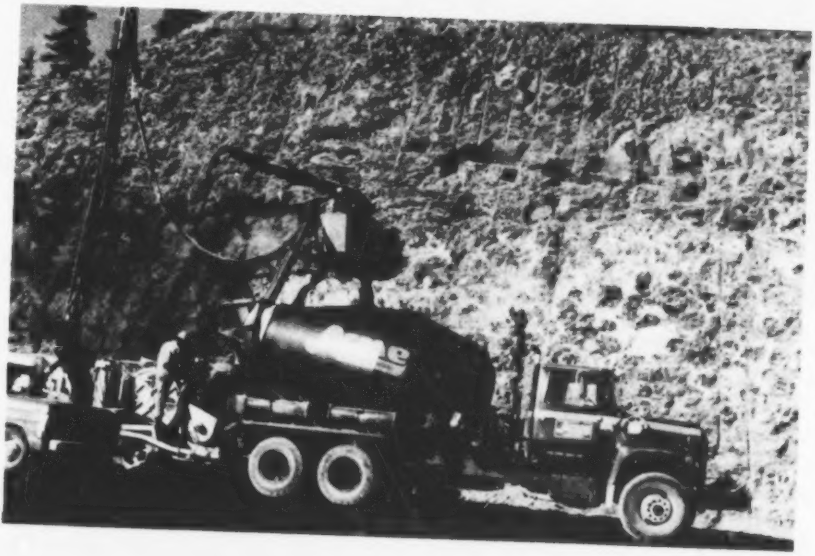

Fig. 3 - Equipment Used

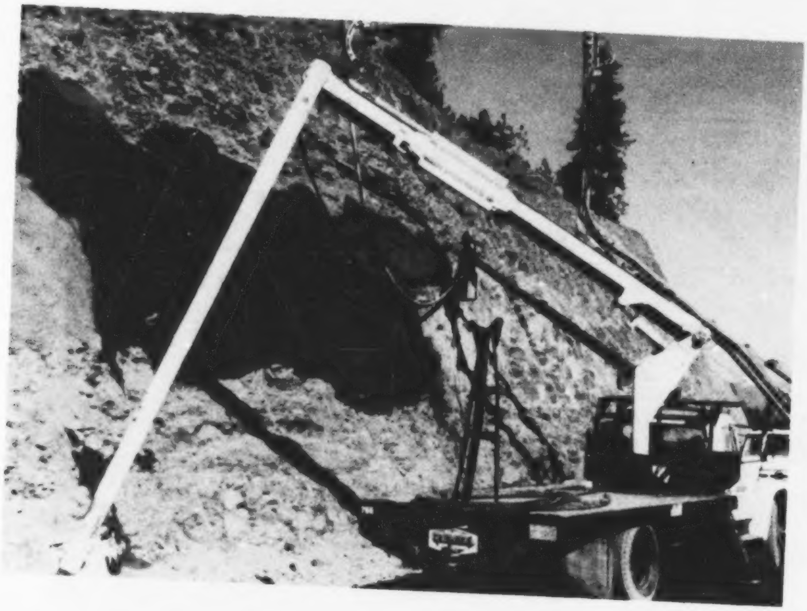

Fig. 4 - Operation Easily Resumed. Note lack of rebound in ditch.

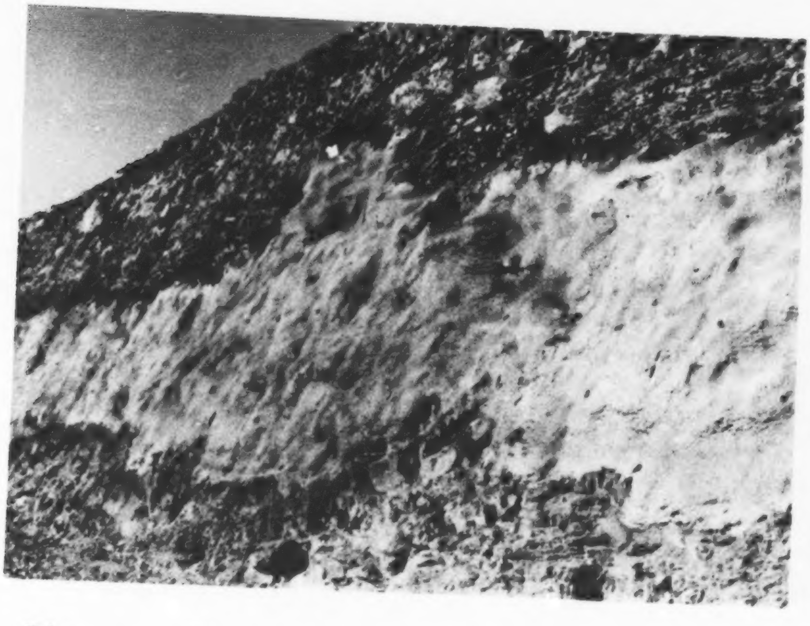

Fig. 5 - Showing hand-formed weep holes. Note lack of rebound in ditch.

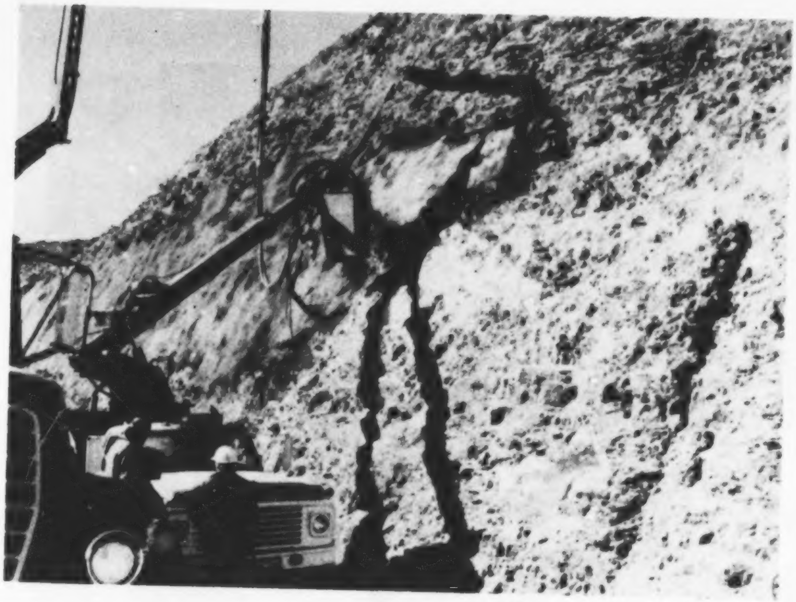

Fig. 6 - View of Palagonite

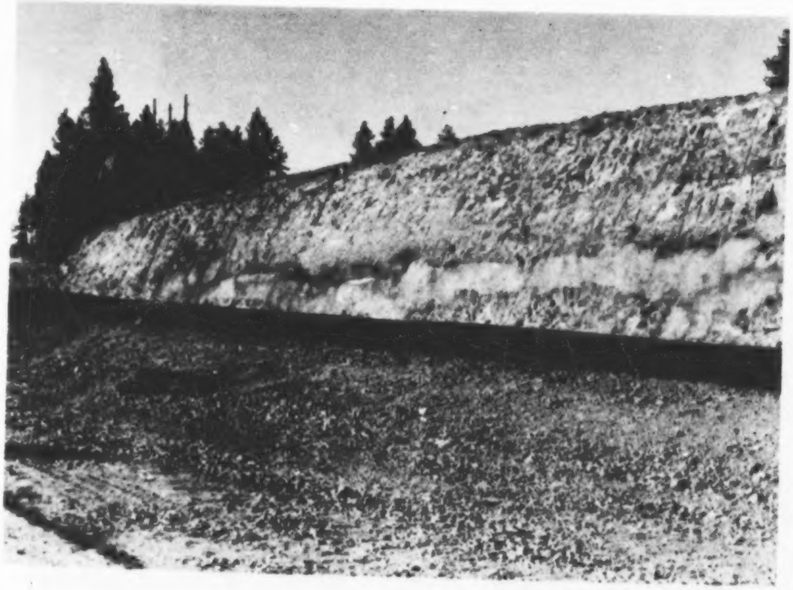

Fig. 7 - Completed Job. Note irregularities in palagonite surface easily covered.

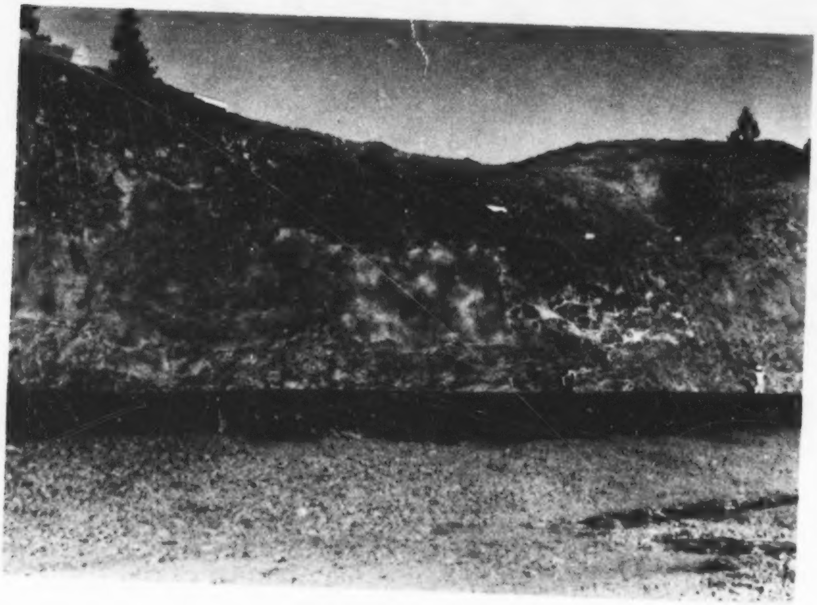

Fig. 8 - Completed job. Again, note irregularities in palagonite surface are easily covered.

Post-Construction Review

Observations of this project have been made periodically in the year since its completion. To date, the material seems to be serving satisfactorily. Figures 9-12 show the conditions as observed July 1979.

The project specification related to the stabilization work items is presented on page 107 of document.

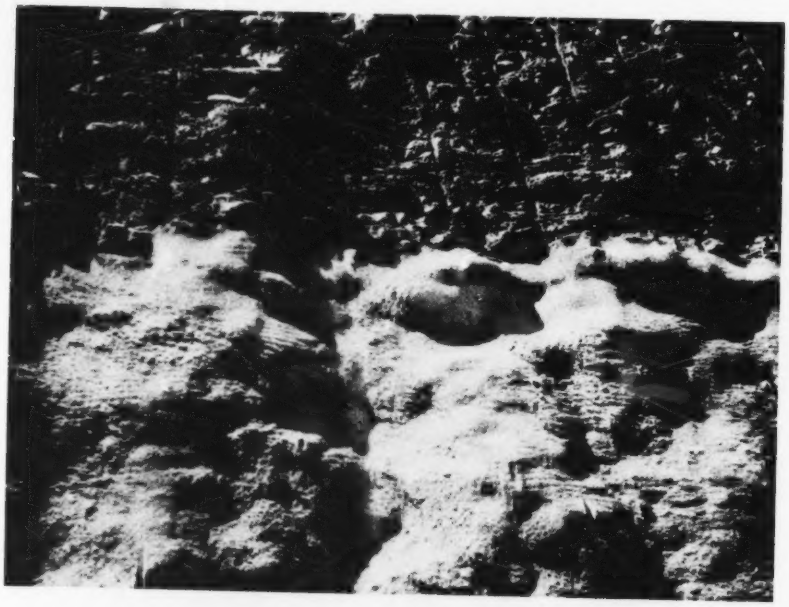

Fig. 9 - An overall view of the stabilized rock. No drainage has been evident from the drain holes in the mortar. There has been no spalling or loss of the mortar at the margins of the installation.

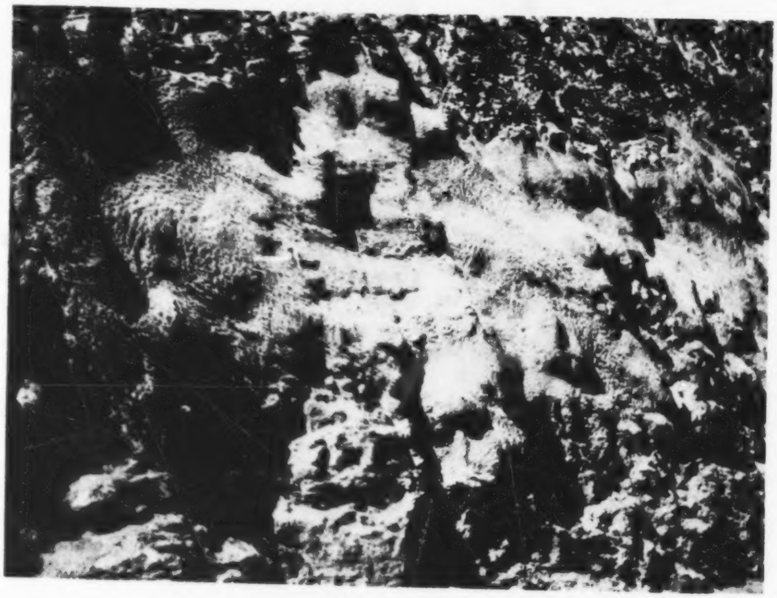

Fig. 10 - Another overall view.

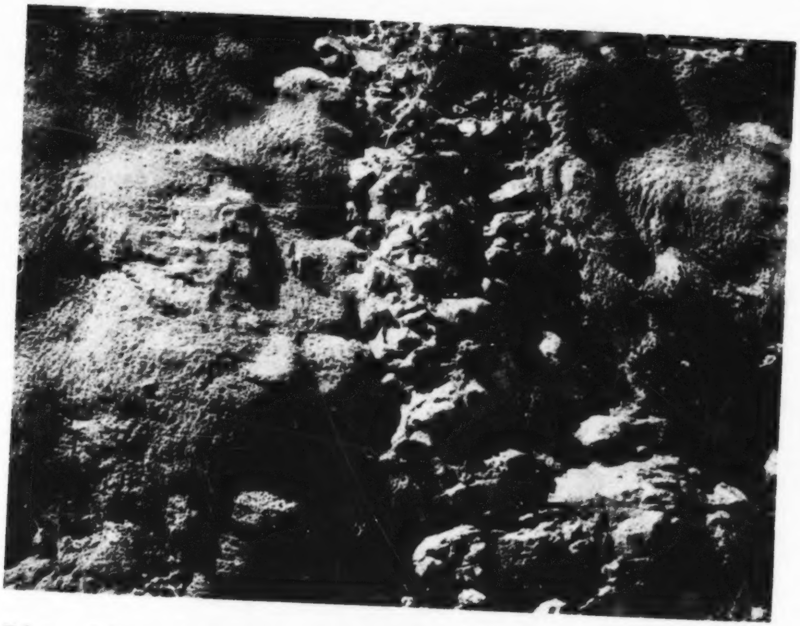

Fig. 11 - A close-up showing an untreated area. The weathering and spalling of the palagonite seams have progressed where unprotected. This minor area was not considered sufficiently significant to cover and has weathered a few inches deep. The surface material in the seam is soft and crumbly.

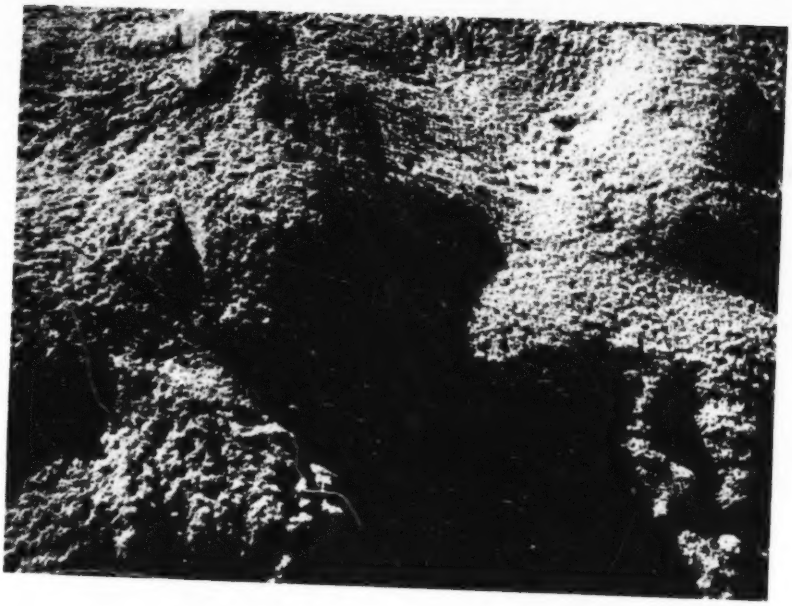

Fig. 12 - Close-up showing hairline cracking. The only notable change to date has been the development of hairline cracks, presumably from shrinkage. Even at the margins of the application area, the mortar covering is sound and intact. It is felt that the use of wire reinforcing mesh is important to maintain integrity, with this type of cracking.

ROCK SLOPE STABILIZATION
Specifications

The excavation slope, on the left from Station 555+00 to Station 575+00, is anticipated to require stabilization treatment of localized areas of palagonite inclusions, in addition to controlled blasting and slope scaling. These areas shall be established by placement of pneumatically applied mortar with or without reinforcing mesh and rock bolts.

Prior to beginning rock excavation in this section, the contractor shall submit a description of his proposed stabilization procedure for approval by the engineer. This description shall include equipment specifications, source, and description of materials and proportions of mortar.

In order to determine areas requiring stabilization treatment, each lift of excavation blasting shall be scaled and cleaned of loose material prior to commencing drilling of the next lift of excavation. Areas to be stabilized will be determined by the engineer and stabilizing work carried on in an expeditious manner. In no case shall blasting and excavating of succeeding lifts be performed until all stabilization work has been completed on the proceeding lift.

Construction of rock slopes by controlled blasting and removal of loose and unsound rock shall be measured and paid as described in sections 2-30.4 and 2-30.5 of the standard specifications. Additional tools, equipment, and materials required for Rock Slope Stabilization as described herein shall be paid as provided under force account, section 1-90.6 of the standard specifications. For the purpose of providing a common proposal for all bidders, and for that purpose only, the State has estimated the cost of the item "Rock Slope Stabilization" and entered the amount in the bid proposal to become a part of the total bid by the contractor.

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